Psychology and Teaching

of

Secondary-School Subjects

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Psychology and Teaching *of* Secondary-School Subjects

BY

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Preface

THE purpose of this book is to set forth the contributions the sciences of psychology and of education have made to the problems of the study and teaching of the secondary-school subjects. The number of scientific investigations of these problems that have been made in the last ten years is far greater than one realizes until he has made a study of the matter. But these investigations are widely scattered. A few appear in books; many appear in various professional journals; and many are hidden in unpublished masters' and doctors' theses. As long as they are in this form they are inaccessible and almost valueless to most of those interested in knowing their results. In this work I have attempted to bring these studies together; to review, organize, and interpret them; and to point out their practical applications for the study and teaching of the secondary-school subjects. In many cases I have had to select one study to represent a group of similar studies, and in some cases, important studies have been left out because of lack of space. I have criticized some of them where criticism seemed to be necessary, but I have not gone in strongly for criticism, for at the present stage of the science, knowledge and appreciation are more important.

I have tried to show that effective teaching depends upon the intelligent application of four fundamental principles of learning, namely: organization or the perception of meaning, practice, adjustment to individual differences, and motivation. The first chapter explains these principles and their various subordinate rules. In

the subsequent chapters an effort is made to show how each of these principles may be applied specifically to the teaching of each school subject. The manner of application is shown by the description of experiments made in classroom situations in which some rule or principle was tried out. Not only is the procedure of the experiment described, but also its results, which makes it possible to evaluate the rule in question.

By this manner of treatment I have hoped to avoid the objection often made to general courses in educational psychology: that they give the student only a *knowledge* of principles of learning but do not enable him to *apply* them to specific learning or teaching situations. These applications cannot be worked out by *a priori* reasoning. On the contrary, they must be worked by actual experiment and practice for each subject and for each mental or grade level. They are very different for typewriting from what they are for foreign languages, and in turn, they are very different for the latter from what they are for social studies. If the specific nature of these applications is pointed out for each subject, then it is possible to translate the principles of learning into actual practice.

In the treatment of each subject the content is limited largely to scientific investigations. In some cases I had to draw on experience, opinion, and *a priori* reasoning, for the simple reason that scientific investigations did not cover the ground. The reason for the restriction to scientific investigations is my belief that the work of the teaching profession should be based on science rather than on experience and tradition. I do not mean that the latter should be disregarded, but rather that whenever they favor a particular procedure or content, such procedures or contents should not be accepted as important for the profession until they have passed the scientific test. Only

in this way can the profession free itself from its superstitions and secure control of its processes.

Although this work is largely restricted to scientific investigations, the reader need not have technical training in order to understand it. Most of the discussion is carried on in nontechnical language so that a reader without training in statistics, educational measurements, and scientific methods can get its practical import. There is, however, an occasional paragraph that is technical in character. Even in the tables most of the data given are nontechnical, and these should be carefully studied.

I am indebted to my students who have assisted me and to all whose investigations I have used. The references given in footnotes throughout the book represent these acknowledgments. I wish in particular to thank Professor E. C. Colyer and Dr. George A. Kelly, my colleagues; Dr. George C. Johnson of Kansas State Teachers College, Emporia, and Dr. J. B. Stroud of the University of Iowa, all of whom read and criticized parts of the manuscript.

HOMER B. REED

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CHAPTER 1

Principles of Learning: Organization, Practice, Individual Differences, and Motivation

Introduction

The psychology of the secondary-school subjects is the science of the activities by which these subjects are learned. It studies not only the activities but also the factors, hereditary and environmental, that influence them. Under activities we study principally learning; under hereditary factors we study the influence of such factors as intelligence, age, sex, race, and native tendencies; and under environmental factors, we study such matters as grade-placement, instruction, content or curriculum, and conditions in home, school, and community. Teaching, as contrasted with science, is the art of applying psychological principles in aiding students to learn. It is a form of applied psychology. If psychology is to be helpful to the teacher, it must be stated in such a form that the teacher can use it. This is one of the aims of this book. The purpose of this chapter is to give the student a brief survey of those principles of learning which constitute the scientific basis of teaching.

The learning process involves three major phases: a goal, a method, and a content. To learn effectively, the student must, first, have a purpose or goal which he intends to reach through his efforts. Second, he must have a technique or method by which he reaches his goal, and third, he must have a content to work on. The first condi-

tion requires a clear statement of the objectives of each subject studied. The second condition requires a statement of the methods which have been found to be most effective for reaching the goal in question. The third condition requires that materials be found which are adapted to the goals, and by the study of which the goals may be reached. The psychology and teaching of secondary-school subjects is concerned principally with the second condition, namely: the methods, techniques, or principles of learning; but the other two conditions must not be neglected, for learning without a definite goal or without suitable materials is ineffective and wasteful.

The methods of learning school subjects may be discussed under four principles: organization, practice, individual differences, and motivation. Organization is the principle by virtue of which facts fall into a pattern and give meaning to the learner. The ease of learning depends upon the degree to which the learner perceives this pattern or upon the extent to which the facts studied have meaning. The principle of organization, therefore, emphasizes the study of relationships—the relations which give unity, coherence, and system to the facts or objects studied. The principle of practice means that improvement in learning is made by repeated efforts to do better. There are certain conditions which must be observed to make this possible: the learner must know the goal that he is trying to reach; he must have some method for reaching it; he must know the results of his efforts; and he must be able to evaluate them with reference to his goal. The principle of individual differences refers to the fact that an individual differs or deviates to a certain extent from the average of his group, and that methods of learning which are to be effective for him must be modified so as to take due account of this deviation. Among

the important differences to be considered in learning are differences in capacity, interest, and needs. The principle of motivation is interpreted to mean that students must have a motive in order to learn. A motive may be thought of as a need felt by the individual which creates a dominant tendency or activity directed toward an object by which the need is satisfied. In animals such needs are mostly organic; in humans they are not only organic, but also emotional and ideational. After these preliminary interpretations, it is appropriate to discuss the principles in more detail.

The Principle of Organization

Organization, as already stated, refers to the perception of pattern or meaning in a group of objects or facts. The nature of the pattern depends in part on the character of the facts and in part on the attitudes of the learner. Patterns become significant in learning only to the extent that they constitute a plan by which the learner may reach some goal. The perception of such patterns has significant relations to the efficacy of learning: it increases the number of facts that can be grasped in one act of thought; it increases the rate of learning; it increases the amount and duration of retention; and it increases the facility for transferring skill from one activity to another.

How the perception of pattern increases the number of facts that may be grasped in one act of attention is shown in memory-span experiments with meaningful and meaningless materials. For high-school students the average memory span or number of members that can be retained after one presentation, is about four for nonsense syllables, six and a half for disconnected words, and about eight for digits. But for words in sentences, the average memory span ranges all the way from fifteen to thirty-

five, the exact size depending upon the meaningfulness and coherence of the sentence. The factor that makes possible this immense increase in size is the pattern or unity into which the elements are organized.

The relation of the perception of pattern to the rate of learning may be shown by experiments in which equal quantities of material having varying degrees of meaning are learned. In one such experiment, the writer [1] selected nine lines of difficult prose entitled "Origin of Ideas," and nine lines of easy prose entitled "Marble Statue." The difficult prose discussed the impossibility of forming images of sensory qualities that were never experienced, while the easy prose was a love story. The time required for the difficult prose was 261.25 seconds, whereas the easy prose took only 111.25 seconds. The same fact is shown in the difference in time required to memorize thirty digits and thirty words in a stanza of poetry. The average time needed by thirty-two students to memorize the digits was 5.52 minutes; for the poetry, it was 1.72 minutes. In an experiment made by Lyon, it was found that 200 nonsense syllables required 93 minutes to memorize; 200 digits, 85 minutes; 200 words of poetry, 10 minutes; and 200 words of prose, 24 minutes. In the memorization of the meaningful materials the perception of pattern reduces the amount of time needed all the way from one half to nine tenths. Sometimes the proportion of reduction in learning time is much greater.

The relation of the perception of patterns or meaning to retention may be seen from experiments in which the number of ideas retained from prose is measured. The writer [2] found that the number of ideas retained from one reading of the selection "Origin of Ideas" immediately

[1] Reed, H. B., "Repetition and Association in Learning," *Pedagogical Seminary*, Vol. XXXI (1924), pp. 147–155.
[2] *Ibid.*

after learning was 11.5, while from one reading of "Marble Statue" it was 49.0. A retention test given after two weeks showed the corresponding scores to be 4 and 39.5, respectively. This indicates that very little of a selection that is poorly understood is remembered, and that what is remembered is quickly forgotten. On the other hand, the amount retained of a well-understood selection is comparatively large, and is slowly forgotten. This fact was also demonstrated in other experiments, notably those by Dietze and by English, Welborn, and Killian.[3] In Dietze's[4] experiment, prose passages of over 1000 words were read once by high-school students. Retention was gauged by the number of ideas retained, as measured by multiple-choice tests given at varying intervals to different groups after the learning. If the retention is measured by the percent of ideas retained of the number contained in the original article, then the amount of retention decreases from 56.7 immediately after learning, to 32.4, thirty days later. If, however, retention is measured by the percent of ideas retained of those that were actually learned from the one reading, then the percent retained decreases from 90, immediately after, to 51.7, thirty days after the original reading.

These figures contrast sharply with the amount retained for nonsense material, as discovered by Ebbinghaus,[5] who measured retention by the amount of effort saved in relearning. According to this method, the percent retained decreases from 58, immediately after, to 21,

[3] English, H. B., Welborn, E. L., and Killian, C. D., "Studies in Substance Memorization," *Journal of General Psychology*, Vol. XI (1934), pp. 233–260.

[4] Dietze, A. G., and Jones, G. E., "Factual Memory of Secondary-School Pupils for a Short Article Which They Read a Single Time," *Journal of Educational Psychology*, Vol. XXII (1931), pp. 586–598, 667–676.

[5] Ebbinghaus, Hermann, *Memory* (Translated by Ruger and Bussenius). New York: Teachers College, Columbia University, 1913.

thirty days after learning. In comparing these results, the reader must keep in mind that Dietze's subjects read the material only once, while Ebbinghaus had his material completely memorized.

In the experiment by English, Welborn, and Killian, retention was measured by summaries or topic sentences covering sections of varying length in the prose passage. The summary items showed either no loss or an actual gain over an interval of fourteen weeks between the learning and the testing. These facts indicate that the rate of forgetting for meaningful prose is radically different from that for meaningless materials. Experiments show that meaningless materials are almost completely forgotten after an interval of 120 days, but we are not entitled to make any such assumption about the retention of ideas for prose, even if it was read only once. It is a matter of speculation just what causes this wide difference in retention, but we may assume that once a pattern or a definite meaning is clearly perceived, it has a stability which is difficult to disturb by the interference of subsequent activities. If so, it is pedagogically a matter of prime importance for the learner to secure a good understanding of whatever he studies.

The relation of the perception of patterns to transfer of training may be seen in the results of experiments in which the perception of relationships was emphasized in the training period. Ruger,[6] in his experiments with puzzles, found that transfer from one puzzle to another involving the same principle was greatly facilitated if the learner first discovered the principle involved in the first puzzle. Judd and Scholkow found that skill in shooting at a target in one depth of water was more readily trans-

[6] Ruger, H. A., "The Psychology of Efficiency," *Archives of Psychology* (1910), No. 15.

ferred to shooting at a target in another depth in the case of boys who were taught the principle of refraction of light. J. C. Peterson,[7] who experimented with the ability to transfer training from one drawing game to another which involved the same formula, found that subjects who discovered the correct formula in the first game saved 89 percent of the trials in solving the second game, while subjects who failed to discover the correct formula, saved only 31 percent of their trials in the same situation. Experiments made by Woody[8] and by Overman[9] in teaching fundamental operations in arithmetic to second-grade children showed that methods in which general ideas of procedure were emphasized showed much more facility in transfer to new situations than methods in which attention was centered upon getting the right answer for the particular problem. All these experiments indicate that the perception of a principle involved in two or more activities greatly facilitates the transfer of skill from one to the other.

The perception of meaning in prose is influenced by chronological age, mental age, and sex of the learner; and by the number of repetitions. Dietze's[10] studies showed that the number of ideas acquired from a single reading of a prose selection increased from Grade VII to Grade XII. Pyle[11] found a rather consistent increase in relation to age for memory of ideas from ages eight to eighteen.

[7] Peterson, J. C., "The Higher Mental Processes in Learning," *Psychological Monographs*, Vol. XXVIII (1920), No. 129, pp. 1–121.

[8] Woody, Clifford, "Some Investigations Resulting from the Testing Program in Arithmetic," *Seventeenth Annual Conference on Educational Measurements*, Bulletin of the School of Education, Indiana University, 1932.

[9] Overman, James Robert, "An Experimental Study of the Effect of the Method of Instruction on Transfer of Training in Arithmetic," *Elementary School Journal*, Vol. XXXI (1930), pp. 183–190.

[10] *Loc. cit.*

[11] Pyle, W. H., *The Psychology of Learning*. Baltimore: Warwick & York, Inc., 1921.

These results indicate that memory for ideas increases with age during the period of growth. The important factor here is probably maturation or growth in capacity that occurs between birth and maturity. It is reasonable to assume that the more mature an individual's mind, the greater is his capacity to perceive relationships, ideas or patterns. Investigators have discovered sex differences in memory for ideas. Some have found them in favor of girls, others in favor of boys. The differences probably result from the quality of material used in the investigations. Memory for ideas, like memory for nonsense materials, is influenced somewhat by the number of repetitions, but not nearly to the same extent. Ebbinghaus, using rows of nonsense syllables, found that for every three repetitions in the learning, he saved one repetition in relearning. In his experiment, the number of repetitions varied from zero to sixty-four. According to this experiment, there is a straight-line relationship between retention and number of repetitions, and the upper limit beyond which further repetitions produce no increase in retention, is very high. In contrast, the upper limit for the number of readings of prose beyond which it is unprofitable to go in order to secure additional ideas, is very low. In an experiment made in the writer's laboratory, in which prose selections of over 1000 words were used with junior college students, it was found that the percent of ideas retained after two weeks was 47.69 for one reading, 54.69 for two readings, 60.15 for three readings, 61.42 for four readings, and 66.42 for five readings. According to these results, the number of ideas retained increase up to five readings—the largest number used in the investigation; but the percent of increase diminishes after three readings. Considering the wide difference in the upper limits for the number of readings used in these in-

vestigations, it is evident that retention of ideas depends on factors other than repetition, the most important of which is probably comprehension. From these results, we may assume that drill procedures have comparatively limited use in school subjects in which the mastery depends primarily upon comprehension or understanding of relationships.

The main conclusion to be derived from these studies of the advantages of the principle of organization in learning is that it contains the secret of economical learning. This means that in order to learn easily and retain well, we should emphasize the importance of the perception of meanings, relationships, or patterns in the material studied. In other words, selection of materials which are meaningful for the learner is a matter of prime importance.

Application of the Principle of Organization to the Learning of School Subjects

If the perception of meaning has the advantages stated in the foregoing paragraphs, it is worthwhile to investigate the extent to which the principle of organization can be applied to the learning of school subjects. A number of investigations have been made, to show that the learning and retention of meaningful materials can be greatly improved. How the principle of organization is applied specifically to the learning of secondary-school subjects will be discussed in later chapters of this book, but at this point, we shall indicate some devices which have wide application, in order to give the reader an idea of the practical value of this principle.

Some devices which experimenters have found to be effective in increasing the comprehension of prose, are: asking advance questions on the main points of the selection to be studied; placing leading questions at the heads

of the paragraphs; simplifying the vocabulary; giving advance directions which will require specific responses; giving advance explanations of content; reading with the intention of finding and retaining central thoughts; including sentence-completion exercises based on the thought of the story; finding the relationship of the title to the central thought; and assigning definite problems to be solved by reading. One reason for the helpfulness of these devices is that they create a mental set which is adapted to the task in question. This applies to all the devices that call for a more or less definite response from the reader, after the readings are completed. The helpfulness of simplified vocabulary is due to another factor, namely, the ability of simple words to arouse meaningful associations.

The factor of meaning, however, is not limited to the study of prose. It has applications to all school subjects, even the learning of combinations in arithmetic, the learning of spelling, and the learning of typewriting—subjects ordinarily thought of as learned principally by drill devices. An interesting experiment that showed the importance of emphasizing relationships in the teaching of combinations in arithmetic was made by Thiele [12] in the public schools of Detroit. Instead of presenting number combinations in their order of difficulty, and, as is the custom, giving one at a time, and as often as is necessary until it is completely learned, he presented the combinations in such a manner as to emphasize relationships. For example, he presented the ten digits in a row, adding one to each digit, then two to each digit, then three to each digit, etc. This enabled the learner to see readily the effect of adding a number to each digit. The per-

[12] Thiele, C. L., "The Mathematical Viewpoint Applied to the Teaching of Elementary School Arithmetic," *Tenth Yearbook*, National Council of Teachers of Mathematics, 1935. pp. 212–233.

cent of error in this mode of presentation was from four to thirteen percent less than in the traditional mode. Another investigator that took advantage of the factor of meaning to learn number combinations was Wilson. Instead of teaching combinations by the drill method, he had first-grade children learn them from games in which numerical scores were kept. At the end of the year, the subjects used in the experiment had accuracy scores ranging from 97 to 100, instead of the 65 percent obtained in most standardized tests.

The introduction of meaning is useful not only in teaching the elementary combinations but also in problem solving. Here one of the most important factors has been found to be familiarity with the situations and terms of the problem. Other helpful devices are emphasis on generalizations or general ideas of procedure, the use of systematic analysis, and the use of diagramming. The helpfulness of these devices is probably due to the fact that they enable pupils to perceive the significant relationships involved in a problem.

The traditional mode of teaching spelling is the drill method, repeating the letters over and over until they can be reproduced without error. Everyone who has tried to reason out how a word should be spelled has found the result to be rather annoying. Despite this fact, experiments show that defining the meaning of the words taught adds greatly to the accuracy of spelling. Typewriting is another subject which is learned principally by repetition. The traditional method of teaching the subject is to spend the first half of a semester in giving drills on meaningless material. An experiment made by Dr. Barton[13] of the University of Idaho showed that typewriting is learned

[13] Barton, J. W., "Smaller vs. Larger Units in Learning Typewriting," *Journal of Educational Psychology,* Vol. XII (1921), pp. 465–476.

very much more rapidly if meaningful instead of meaningless material is used. In his experiment, he had students write a business letter on the first day, using a chart on the board as a guide for striking the correct keys. His results showed that in proportion to the amount of time spent in learning, the pupils who had connected material made three and a half times as much gain as the pupils who used disconnected material.

The perception of a pattern of organization is helpful in writing a composition. After one sees the relation of a theme to its various sub-topics, there is little difficulty in filling in the details. Beginning pupils often need assistance in formulating such a pattern, but once it becomes evident, there is much improvement in the quality of composition.

The study of a foreign language is another subject that is aided measurably by the perception of relations. These are numerous and complex. The student must learn the relations of a foreign word not only to its English equivalent but also to word order, to other words necessary for completing a thought, to grammatical principles, and to forms of expression. If a student sees these relations, learning a language becomes meaningful, rational, and easy. If he fails to see them, the task becomes a case of meaningless and painful repetition.

Since most of the material used in teaching social studies and science is reading matter, it is reasonable to suppose that those devices used for increasing comprehension of meaningful prose can be applied directly to the reading of materials in these subjects. Experiments have shown that this is the case. Two devices that have been found particularly valuable in teaching social science are outlining, and simplification of the vocabulary. Each increases meaning.

The study-guide method has been found to be very profitable in teaching high-school zoology and physics. Experiments show that high-school students make considerably more improvement in physics and zoology when they follow this procedure than when they use traditional methods. These enlarged gains are undoubtedly due to the fact that the study-guide method emphasizes the importance of meaning, or significant relationships.

The foregoing paragraphs on the applications of the principle of organization lead us to conclude that it is one of the major factors in learning and that it has possibilities of extensive use.

Practice

Practice is an important factor in the learning of any school subject. Although it is possible with little practice to comprehend certain ideas and relationships, it is seldom possible for the unpracticed to use them effectively in problem-solving. Practice adds facility, accuracy, and speed to a response and not infrequently is a factor in improving comprehension. Sometimes a student practices an activity simply because he is directed to do so, and comprehends very vaguely what it is about. But after he practices the activity for a while and sees the results of it, he understands it. Such processes as cancellation in fractions and dividing by a fraction are often not understood until practiced for some time. To practice effectively the learner should know the goal to be reached by his efforts; he should have some idea of the method of attack; he should have knowledge of the results of his efforts; and he should have frequent summaries of his progress. The first two conditions are evident when it is understood that an effort must have direction and some method of procedure in order to accomplish anything.

The importance of knowledge of results has been shown in a number of experiments. One of the clearest is Thorndike's experiment in line drawing, which was conducted by withholding from the learners all knowledge of the results of the efforts made. From it Thorndike[14] concluded that the mere repetition of a response has no effect whatever in changing it. This, however, is not true when the learner has an idea of the goal to be reached by the repetitions and can evaluate the results of his efforts.

Evidence of the above was shown in an experiment made by the writer in which college students practiced drawing lines, rectangles, and circles, under four conditions each representing a difference in the degrees of knowledge of results, namely: (1) when the subjects were blindfolded; (2) when the subjects had their eyes open but had no other means of measuring the accuracy of their results; (3) when the subjects had a standard before them and could make visual comparisons between the standard and their drawings; and (4) when the subjects measured every fifth figure drawn and calculated the exact amount of error. The first condition yielded no consistent improvement. Some had less error at the end than at the beginning of the experiment, but others had more. The average amount of error for the entire group was greater at the end than at the beginning of practice. As soon as knowledge of results was introduced, however, immediate improvement began, amounting in proportion to the accuracy of the knowledge of the results. As soon as the student saw the results of his work, he began to make corrections in the direction of his idea of the length of a four-inch line. Further improvement was made when he had a chance to compare with standards the figures

[14] Thorndike, E. L., *Human Learning*, New York: D. Appleton-Century Company, Inc., 1931.

that he drew; and still further improvement when he had an opportunity to measure each figure and calculate exactly the amount and direction of the error.

Similar results were found by Ross,[15] who had students practice the making of tally marks under three conditions: (1) when they had no information about the results, (2) when they had partial information, and (3) when they had full information. The group which had full information made more improvement than the group that had partial information, and the group that had partial information made more improvement than the group that had no information. These experiments indicate that practice in and of itself, as Thorndike said, is valueless, but when combined with knowledge of the goal and of the results, then it produces improvement. It is evident that if this information is given frequently, it is more effective than when it is given infrequently.

Factors Influencing the Efficiency of Practice

The amount of improvement that may be derived from a given amount of practice depends on a number of factors. Among them are *the distribution of effort in time, the distribution of effort in space, the distribution of effort according to the difficulty of the task, the intensity of the effort, the amount and kind of guidance received, the sensory avenue* by means of which the practice material is perceived, *the application of effort to the point of error, the application of effort to real or unreal situations,* and *the application of effort to useful activities.* In the remainder of this section, we wish to point out the influence and the importance of these factors.

Distribution in time. The rule for distribution of

[15] Ross, C. C., "An Experiment in Motivation." *Journal of Educational Psychology,* Vol. XVIII (1927), pp. 337–346.

effort in time is as follows: within certain limits the more distributed the efforts the greater the amount of improvement made. This has been shown in experiments made in typewriting, ball tossing, javelin throwing, archery, addition, multiplication, division, and a number of other processes. It is clear that some form of distributed practice is better than practice that is highly concentrated, but there are no definite rules about the exact length of the practice period or that of the interval between practice periods. Practice periods may be either too long or too short, and the same is true of the length of the interval between them. Certain factors which influence economical distribution of practice are the age of the learner, the quality of the material, and the completeness of the work accomplished in a given period. High-school pupils can undergo longer practice periods than primary pupils because the former are less subject to fatigue and boredom. Practice periods in translating a foreign language or in solving involved problems must be longer than drills for learning the elementary combinations. This is true partially because a practice period is unprofitable unless a given task is completed. This is probably why one 15-minute period a week in solving verbal problems is better than five 5-minute periods. The best distribution of effort must be discovered by experiment with each kind of task and for each grade of pupils. Some theories for explaining the superiority of distribution of practice are that it produces less fatigue, secures more intense effort, gives an opportunity for the processes involved to consolidate, and gives an opportunity for the mechanisms to mature during the interval of rest. Which of these factors is the most important is not known.

Distribution in space. The distribution of effort in space has reference to the use of the whole, part, and part-progressive methods of learning. The methods are impor-

tant because of their close relation to the unit-assignment method and the daily-recitations procedure in classroom work. In the whole method, the learner goes over the entire task from beginning to end until it is mastered. In the part method, he masters each part separately and then all of the parts together. In the part-progressive method, he learns the first part, then the second part, and then the first two together; then the third part, and then the first three together, etc., until the entire task is learned. Each method has certain advantages and disadvantages. The whole procedure gives the meaning of the material better than the others, but it often produces bewilderment and usually causes attention to lag in the middle of the piece. The part procedure adjusts the material to the capacity of the learner, gives a quick perception of progress, and produces a more intense effort; but it often produces a weak connection between parts and misleading associations from one part to another. The part-progressive method combines the advantages of both of the other procedures, and is free from most of their disadvantages, but it does not yield the meaning of a piece quite as soon as the whole method. For most people it is the most economical procedure, but some individuals find the whole method the more economical; and others, the part method. There appears to be no one best method for all learners. The economy of these methods is influenced by various factors. Experiments indicate that the economy of each procedure is influenced by the size of the unit, by the maturity of the learner, and by his intelligence. The longer the unit, the less advantageous the whole method appears to be; and the more mature and the more intelligent the learner, the more advantageous it is likely to be.

Distribution according to difficulty of the task. A difficult task should require more effort than an easy task. In spite of the obviousness of this statement, it is often

violated in practice, particularly in mathematics. A number of investigations show that easy combinations in arithmetic occur much more frequently than difficult ones. The same is true in algebra and probably in words in spelling, expressions in English, and some facts in the social studies. To correct this tendency, we should have studies showing the relative difficulty of the various tasks required in each subject, and of the proportionate amount of effort required to master each. The improvement in teaching in this direction, therefore, depends upon scientific research.

Intensity of the effort. Vigorous effort is more effective than mild effort. This rule is also rather easily ignored, probably because of a tendency in human nature to conserve energy. The influence of the intensity of effort in learning has been shown in experiments made by Gates,[16] and by Smith and McDougall.[17] In Gates's experiment, students learned rows of nonsense syllables and short biographies in two ways: first, by spending the entire period in silent reading of material, and second, by varying the proportion of time between silent reading and recitation. In the recitation method, the student recalled the material by his own efforts, and looked at the copy only when recall failed. The results showed that the amount of retention was closely proportional to the fraction of time devoted to the recitation method. The superiority of the latter is probably due to a number of factors, but the most important appears to be the greater intensity of the effort used. In the experiment by Smith

[16] Gates, A. I., "Recitation as a Factor in Memorizing," *Archives of Psychology*, (1917), No. 40.

[17] Smith, M., and McDougall, W., "Some Experiments in Learning and Retention," *British Journal of Psychology*, Vol. X (1919–20), pp. 199–209.

and McDougall, the relative values of active and passive attitudes in learning were compared. Under the active attitude the students made an effort to learn rows of nonsense syllables as soon as possible. In the passive attitude, they simply repeated the syllables mechanically. The average number of repetitions required to learn under the active method was three, while under the passive attitude, it varied from 89 to 100.

Guidance. The effectiveness of practice depends upon the amount and kind of guidance and the time at which it is given. In a broad sense, the term "guidance," refers to any advice that makes learning more proficient; but in the strict sense, it refers to aid in the specific operations for doing a task. It is in this sense that the term is used here. Experiments have shown that mechanical guidance to rats learning a maze increases rather than decreases the number of trials required, but the contrary is true for humans. In general, it may be said that the value of guidance decreases with the amount given, that verbal guidance is better than mechanical or manual guidance, and that it is more effective when given early rather than late in the learning period. The objection to a great amount of guidance is that it creates an attitude of dependency on the part of the learner and deters him from using initiative and putting forth effort. The superiority of verbal over manual or mechanical guidance is probably contained in the learner's ability to secure the idea of the task to be done more clearly from the verbal directions than from the other forms. The value of the verbal form, however, depends upon the kind of words used. A concrete rule applied to a particular case has been found more effective than an abstract general rule applied to a variety of cases. This is probably due to the fact that

concrete words are more easily understood than abstract ones. Guidance early in the learning is more profitable than that given later because wrong habits which produce interference are not yet formed. It is better to give it after the initial exploration because then the learner has a better set for his task and is capable of better discrimination between right and wrong movements.

Influence of sensory avenue. The sensory avenue through which the learning matter is presented is in most cases unimportant, but in certain instances, it becomes important. A combination of auditory and visual presentations has been found more effective for learning nonsense syllables than either alone. This doubtless follows from the fact that clarity is increased by the combination. Some objects such as geometrical diagrams can be presented far more clearly in visual form than auditorily. The same is true of the process of cell division in animals, or of growth in a plant, or of types of motion to be used in the industrial and fine arts. If these processes can be perceived visually by means of diagrams or motion pictures, there is no doubt that it will increase the ease of learning. Principles, theorems, and generalizations, on the other hand, can be perceived more clearly in auditory form, or through reading if the visual form is used. The effectiveness of sensory avenue appears to depend upon its relation to the clarity of the presentation. In general, we may say that the most effective sensory avenue is the one that gives the learner the clearest idea. What this is will depend upon the character of the fact to be learned.

Application to the point of error. Effort expended in correcting errors produces more improvement than that expended upon activities that are fairly well known. This rule, too, is often neglected. The usual procedure is to conduct students through a certain course or to give a cer-

tain course to them, taking no account of which parts of the course are known or not known by the students. The teacher usually proceeds on the assumption that none of the material is known and that all of it needs equal emphasis. Experimental investigations of learning processes, however, demonstrate the fact that this assumption is not true. Certain parts of every course are known before they are taught, others are learned very quickly, and others are learned with much difficulty. The value of concentrating efforts on the correction of errors has been shown in experiments in learning the fundamental operations in arithmetic, typewriting, handwriting, spelling, and English. In these cases, students who were required to concentrate their efforts upon the correction of errors made far more progress than those who followed the regular course, regardless of the individual needs of pupils. Although this type of teaching is effective, nevertheless it is not easy, for it requires the teacher to make frequent diagnoses by means of tests. Such tests require not only careful and lengthy preparation, but also much time to score. After the difficulties are shown, it is a hard task to devise adequate remedies. Too often the teacher does not have the material necessary for making a diagnosis or for formulating adequate remedies for the difficulties found.

Application to real and unreal activities. An activity should be learned in the way in which it is to be used in life situations. Experiments made in typewriting and in handwriting show that the nearer instruction is to life situations the more effective it is. In handwriting it used to be considered good pedagogy to spend a long time in practicing the right posture and in practicing writing movements which are never used in actual writing. But this idea has little acceptance now. If children are to learn handwriting, it is best for them to practice letters

and words actually used in writing. Similarly, in typewriting it was once considered good pedagogy to spend much time on finger exercises rather than on writing meaningful composition. This idea too is losing its popularity. Teachers of typewriting are coming to believe that it is more economical to practice writing real composition. Artificial or unreal activities invariably contain elements not used in real activities, and develop habits which interfere with the activities needed in life situations. The need of using learning activities which imitate life situations does not mean that attention should not be paid to the difficulty of the material. Good judgment requires that the simpler tasks should be learned first.

Applications to useful activities. The advice that learning activities should be imitations of life situations is but another way of saying learning situations should be devoted to useful activities. Modern education is coming more and more to the view that the curriculum should be free from dead wood and that it should contain material which increases efficiency in life activities. This movement began first with the elimination of useless letters in spelling. The time that can be devoted to any one subject is limited and the amount that can be learned about it is limited. Under these conditions, economy requires that learning situations be restricted to the useful. However, too narrow an interpretation must not be made of the term *useful*. Useful to life does not necessarily mean useful only to the average man in the street, or to the greatest number of people, nor does it imply the most frequently used activity, nor is it to be taken in the economic sense alone. It does mean, however, that an activity should be useful to someone, whether the individual or society, but principally useful to the one who has the task of learning.

Individual Differences

Learning is always done by the individual. The effects of learning are changes in the individual, either in his habits, his attitudes, or his beliefs. The material learned should meet some need in the individual, and should be adjusted to his capacity. The methods used also should be suitable to him. Since this is so, the individual's interests, capacities, and needs are primary factors in any learning situation. It is the purpose of this section to discuss the importance of these factors in learning, to give an account of their causes, and to outline the principal procedures by which instruction may be more adequately adjusted to individual needs.

Instruction in the schools is conducted for the most part on the assumption that the individuals of the group are all alike, but as a matter of fact, they are all different. The difference of an individual from the average of the group is probably the most important fact about him, for it determines his place in the world. How individuals differ from each other is shown in the so-called normal-distribution curve. Figure I shows the character of this curve. It gives a distribution of high-school pupils for each of the grades, IX to XII, inclusive, for the results obtained from the paragraph test in the Nelson-Denny High-School Reading Test. The results were obtained from a total of 2,058 high-school pupils located in fifteen high schools in Kansas,—638 pupils from Grade IX, 526 from Grade X, 465 from Grade XI, and 429 from Grade XII. The score represents the number of points for answers to comprehension questions on paragraphs. The pupils from each grade of high school cover approximately the same area of the scale. Both the highest and the lowest scores for the entire group were made by freshmen. The median score, however, changes, with advance-

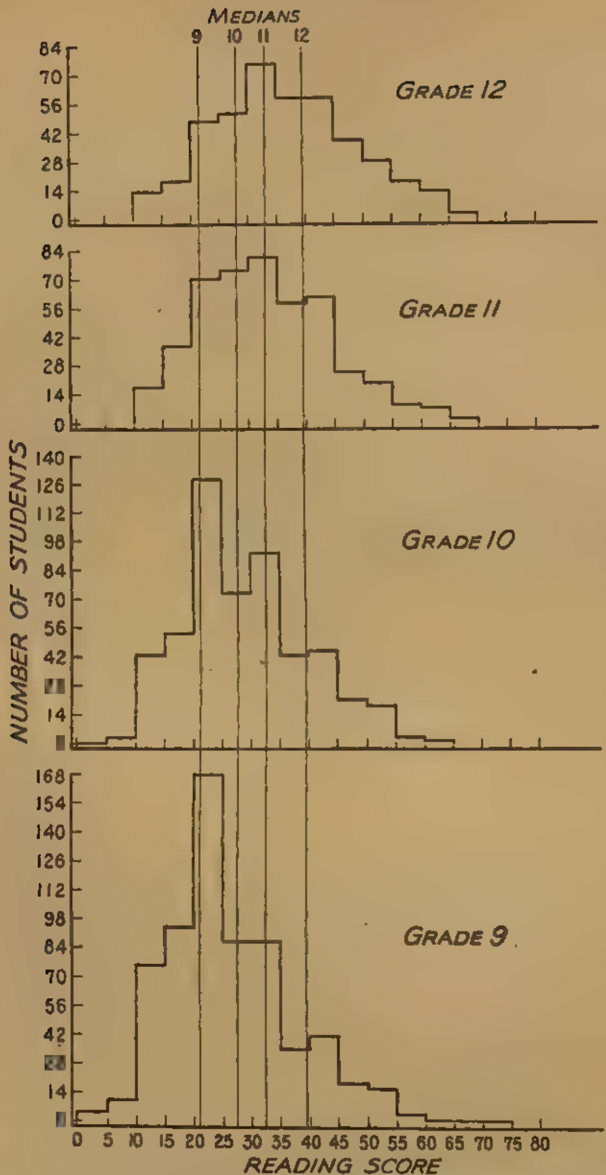

Fig. 1. Distribution by grades of high-school pupils in Nelson-Denny paragraph-reading test.

ment through the grades. It is 20.98 for Grade IX, 27.6 for Grade X, 33.1 for Grade XI, and 39.64 for Grade XII. The difference between grades is only six or seven points, but differences between the highest and lowest pupils in each grade vary from 60 to 65 points. The advancement in the median is probably due more to the elimination of the poorer pupils in the upper grades than it is to the improvement in reading ability in those who remain. So far as group instruction in reading is concerned, the entire high-school group could be taught as one, but such instruction would be adjusted to probably only one third of the pupils. The important fact about these distributions is the smallness of the differences between the medians contrasted with the largeness of the differences between the individuals in any one class. As a matter of fact, the instruction is based upon the differences in the median scores of different grades, but it should be based on the far more obvious and greater differences which exist between individuals. What is true of individual differences in reading ability is true also of individual differences in any other subject that is taught consistently throughout high school. Subjects which are taught in only one year and not further emphasized, such as rhetoric or grammar, usually show decline in achievement after the study stops. Because of this, high-school seniors often make lower scores in these subjects than do high-school freshmen.

Causes of Individual Differences

The causes of individual differences are found both in heredity and environment. That heredity is a factor is shown in the family histories of exceptional people, famous and infamous; in the correlations between traits of related and unrelated individuals, in the studies of iden-

tical twins, and in the studies of the variations of mental levels of children in relation to the occupational level of the parents, and in the facts of maturation. The influence of environmental factors is shown in studies of the effect of foreign influences on the structure of the embryo, studies of foster children, studies of the influences of training on variability of achievement, and in studies of the decline of intelligence quotient of children reared in poor environments. Among the best known family histories are those of Galton on *Hereditary Genius*, and those of Goddard on *The Kallikak family*. The 977 British men of genius studied by Galton had 574 equally famous relatives, 362 of whom had the relationship of father, brother, or son, and 212 of whom had the relationship of grandfather, grandson, uncle, or nephew. Certain computations made by Galton showed that the son of a famous man had one chance in four to become equally famous, the grandson had one chance in 30, and the great-grandson had one chance in 200. This indicates that the individual's probability of becoming famous is directly proportional to his degree of kinship to the famous man.

The history of the Kallikak family is interesting because of the fact that the common ancestor, Kallikak, had two lines of descendants, one respectable and the other not. The infamous line descended from an illegitimate son of whom 480 descendants were traced in direct line. Of these, 143 were known to be feebleminded, and only 46 normal; 36 were illegitimate, 33 sexually immoral, 34 prostitutes, 3 epileptics, 3 criminals, 8 keepers of houses of ill fame, and 83 children so feeble that they died in infancy. The respectable line descended from the wife and consisted of 496 descendants, most of whom were people of superior ability, who held positions as lawyers, doctors, teachers, business men, and presidents of colleges. This

study indicates that fame as well as infamy follows the kinship line. Both of these studies, however, are open to the objection that the influences of heredity and environment are intermingled and do not show the influence of one factor apart from the other.

The correlation studies of mental traits show an increase in the correlation with the degree of kinship between the individuals correlated. These studies show correlations ranging from zero for those between unrelated individuals to .90 for identical twins. Correlations between individuals having other degrees of kinship lie between these points. For example, the correlation between cousins is .27; between brothers and sisters, .50; and between fraternal twins, .70. It is difficult to explain this increase in correlation with the increase in kinship on any other basis than heredity or common genetic factors.

The studies of identical twins reared apart throw an interesting side line on the influence of heredity. So far, the case histories of too few pairs have been published to establish final conclusions. Some of the pairs show almost no difference in spite of the fact that the members were reared in very different environments, while others show a considerable difference. Newman found that the average difference in intelligence quotients for these pairs was 8.6 points, as contrasted with 5.3 points for 50 identical pairs reared together and with 9.9 points for 50 pairs of fraternal twins reared together. The fact that identical twins reared apart show less difference than fraternal twins reared together presents a strong case for heredity. A study made by Hirsch points to the same conclusion. He found that dissimilar twins reared in a similar environment had an average difference of 13.8 points in intelligence quotients, while similar twins reared in a sim-

ilar environment had a difference of 2.3, and similar twins living in a dissimilar environment had only 3.5 points difference. The conclusion to be drawn from all these facts is that heredity is at least one factor accounting for likenesses and differences between individuals.

Many of the changes that occur in relation to maturation or growth are very evident, especially the changes in height, weight, form, and capacity. They appear to be due primarily to heredity, although it is clear that environmental influences play a large part both in the amount and in the rate of these changes. One reason for believing that heredity is a primary factor in these changes is that under a relatively constant environment the child, or any other organism, grows until he reaches a certain size and age and then stops growing. This would not be expected if environment were the determining factor.

That heredity is only one factor in causing individual differences is shown by the studies of the influences of environment. Contrary to the idea that bodily structure is due entirely to heredity are the facts presented by Child on the effect of foreign influence on the structure of the embryo. His studies show that monstrosities are due to the foreign influences acting on the embryo and that the rarity of abnormalities in the offspring of animals and humans is due to the uniformity of environment during embryonic life.

Studies of the relation between the frequency of geniuses and opportunity, such as those made by Odin and Cattell, indicate that the frequency of geniuses is largely a product of the opportunities which an individual has. It is to opportunity that Odin credits the fact that, in relation to population, geniuses are over 150 times more frequent in nobility than in the laboring class, 50 times more frequent among the educated than the uneducated,

10 times more frequent among the wealthy than among the poor, and 13 times more frequent in the city than in the country. A study made by the writer on the influence of training on variability in achievement indicated that differences in achievement are due largely to differences in opportunity. In an experiment in tossing the yo-yo top, it was found that in the first performance the poorest individual made only two catches, while the best individual made 400 catches. After 18 practice periods of 10 minutes each, one of the poorest individuals made 530 catches while the best of them made 660 catches. Another of the poorest made 262 catches in the eighteenth performance. Although at the beginning of practice the best individual was 200 times as efficient as the poorest, at the end of eighteen practice periods, he was less than three times as efficient. This indicates that the wide difference between the individuals at the beginning of practice was due to the lack of opportunity of the poorest individual to learn this game; but after the best and the poorest had had the same opportunities for some time, the relative differences between them were much reduced. Such results suggest the idea that differences in achievement may be accounted for in large degree by differences in opportunity, and that one method of reducing inequalities between individuals is to equalize opportunities. It is possible that this statement applies to inequalities other than those existing in learning situations.

The influence of environment on individual differences is also indicated by changes in I.Q.'s in relation to changes in environment. Foster children who were placed in good homes increased their I.Q.'s, while those who were placed in poorer homes decreased them. The same is true of declines in I.Q. which occur between early childhood and late childhood in own children when they are reared in

an unfavorable environment. An illustration of this was shown in Gordon's study of canal-boat children in England. He found that very young children had normal I.Q.'s but that the older children had I.Q.'s which bordered on feeblemindedness. He attributed this decline to the poor, monotonous, and unstimulating environment in which the children were reared. Such facts show that environmental factors are very important in explaining differences between individuals, and indicate that the traits of individuals may be to a large extent controlled and determined by operating on the environment. This is the teacher's chance to change the individuals in his charge.

Plans for Adjusting Instruction to Individual Differences

Grade classification. The first adjustment of individual differences made by schools was that of grade classification. That this is necessary is shown by the developmental changes that occur in children of school age. In the secondary-school period, which usually occupies ages twelve to eighteen, the changes are almost as marked as those occurring during the elementary-school period. During the ages from twelve to eighteen the boy changes in average height from 58 to 68 inches, and the girl from 58 to 64 inches; the boy changes in average weight from 77 to 128 pounds, and the girl from 78 to 117 pounds. There are also marked changes in interests. At twelve the more prominent interests among boys are playing catch, cowboy, and marbles; riding a bicycle; reading adventure stories; and being part of a gang. At eighteen his interests are in baseball, football and other sports, reading about science and mechanics, reading newspapers, social dancing, "dates," church, and religion. At twelve

the girl's interests are in dolls, school, jacks, juvenile fiction, and home activities. At eighteen they are in parties, social dancing, romance, adult fiction, church and religion, and organized social groups. The changes in mental level between twelve and eighteen are indicated in the Stanford revision of the Binet-Simon scale by a change in vocabulary score from 40 to 75, a change in ability to define words like *charity* and *pity* to defining the difference between *evolution* and *revolution*, and a change in ability to reproduce five digits backwards to ability to reproduce seven digits backwards. Educationally, these changes in mental level mean a change from ability to do long division to ability to do geometry, advanced algebra, analytics, or trigonometry, or a change from ability to read the first paragraph given below to ability to read the second paragraph and answer the accompanying questions.

Both before and after Christmas, Bob Adams worked harder than he did in the spring, summer or fall. Only very rarely did he reach home before eleven o'clock; and on every morning except Sunday he was up at six, dressed and done with breakfast by quarter of seven, left the house at ten minutes of seven and reached Mr. Clark's store at ten minutes of eight. In spite of the long hours and hard work, he was happy because his pay had been raised twice.

> About how long did it take Bob to go from the house to the store?
> How often each week did Bob stay in bed after six?
> What did Bob do between six and seven A.M. six days out of the seven?[18]

There are two methods by which one might make himself acquainted with anything made up of related parts; as, for example, a watch. He might take the watch apart, piece by piece, and while doing so study the details of its structure and the relation of its parts one to another. An operation like this, which begins with the whole and descends to the parts which compose the whole, is called analysis. The word means a taking apart or separating. Or he might begin with the parts, and, after some experiment and study, get an

[18] *Thorndike-McCall Reading Scale,* Form 2, p. 4. New York: Teachers College, Columbia University, 1922.

excellent knowledge of the watch by putting its parts properly together. An operation of this kind is called synthesis.

> Name in order the method which (a) is easier, (b) requires more originality.
> Experimentation is more essential with which process?
> Copy the words which tell what a mechanism is.[19]

The justification for grade classifications lies in the fact that they make a partial adjustment for the differences that occur in relation to maturation. Their inadequacy is due to the fact that these differences are much larger between individuals of the same grade than they are between the averages of the grades in the secondary school; but the differences are ignored in the traditional grade classification.

Since the discovery of the importance of individual differences and of the inadequacy of grade classifications, a number of instructional plans have been developed to cope with this unsatisfactory situation. These plans attempt to socialize the individual and to prepare him for self-maintenance and membership in a social order by methods which are different from the ordinary. The new methods include the essentials of the usual curriculum and attempt to adjust such essentials to differences in individual capacity rather than to differences in interests or in needs. Differences in capacity are accommodated by (1) variations in rate, (2) variations in quantity, (3) variations in quality and, (4) combination of these. All plans which have a special name are in a sense combinations of the first three features, but some give more emphasis to one than to another. Those which emphasize variations in rate are *homogeneous grouping, the Dalton Plan,* and *the Winnetka Plan.* Those which emphasize variations in quantity are *the Morrison Plan, the Differentiated-assignment or Wisconsin Plan, the project or*

[19]*Ibid.,* Form 1, p. 7.

problem method, and other unit-assignment methods. The case-study method and advisory programs combine and select those features which seem best suited to the individuals advised. We shall state the salient features of each of these plans and discuss their advantages and disadvantages for the purpose for which they were designed. Their special application to particular subjects will be considered when we take up the special subject-matter fields.

Homogeneous grouping. Homogeneous grouping refers to refined classification, one that is based on criteria which are thought to be more adequate than the traditional one of chronological age. According to Billett [20] it is the most widely used of the various plans designed for meeting individual differences. With respect to type of school organization, it is used most widely in junior high school. In regard to subject-matter fields, it is utilized most frequently in the academic subjects, somewhat less often in the commercial subjects, and least frequently in the nonacademic subjects. The frequency of its use increases in relation to the size of the enrollment. Its adequacy depends upon the breadth of the base upon which the grouping is made, and upon the differentiation of the instruction with respect to the abilities and needs of the group. Billett found 16 bases used for grouping. Those which were valued most highly were intelligence quotient from group mental tests, and chronological age; those which ranked second in importance were group intelligence test scores, or mental age and educational or achievement quotient; those ranking third were average scholarship marks in all subjects combined, average scholarship marks in subject studied or related subjects, edu-

[20] Billett, Roy O., "Provision for Individual Differences Marking, and Promotion," *National Survey of Secondary Education*. Monograph No. 13. Washington, 1933.

cational achievement or test age, or teachers' rating of pupils' academic abilities or intelligence; fourth in importance were intelligence quotient from individual tests, industry, social maturity, and physical maturity; and those which ranked fifth or lowest in importance were individual test scores or mental age, health, and type of home environment.

These criteria represent a peculiar mixture of objective and subjective scores. One half of them are subjective—those related to scholarship, academic ability, health, industry, social maturity, physical maturity, and type of home environment. The subjective scores appear to have equal rank with the objective ones. Chronological age, although a minor factor in educational achievement, ranks equally with intelligence quotient and higher than mental age. Of the objective scores, intelligence quotients and educational quotients rank higher than mental age or educational age. The adequacy of these criteria depends upon the purpose for which they are used. If the purpose is grade classification, then the primary factor should be capacity—which is represented by mental age, educational age, and chronological age. Intelligence and educational quotients are useless here, for it is possible for a pupil in Grade I to have just as high a quotient as a pupil in Grade X. Since there is almost no skipping of grades in high school, the principal purpose of homogeneous grouping is to adjust the instruction to the needs and abilities of the pupils in a particular subject. The first division should be made upon levels of capacity. After these levels are separated, further classification may be made on the basis of quotients and industry, both of which represent rate of learning. Since the purpose of homogeneous groupings in high school is nearly always that of making instruction more adequate or efficient in a par-

ticular subject, it appears that those criteria most closely related to the subject in question are the only ones that need to be considered. These are mental age, intelligence quotient, achievement or prognostic test score in the subject in question, and achievement in related subjects. What a pupil does in industrial arts or physical education has little importance in relation to what he does in English or algebra. To be sure, no school uses all of the sixteen bases. Many use only a single basis such as intelligence quotient. The more frequent error is to use too restricted a basis for grouping rather than too wide a basis.

A number of scientific studies have been made of homogeneous grouping. The results are not all consistent. In general, it may be said that homogeneous grouping is of most benefit to the slow group. It is next most beneficial to the average group, and least beneficial, and often harmful, to the fast group. Some reasons for its beneficial effects are that it greatly reduces the range of differences to which the instruction must be adjusted, it increases the ease of finding satisfactory materials for the group, and it favors the opportunities for motivating the average and slow groups. The principal disadvantage of homogeneous grouping is that the instruction is still based on group rather than individual needs, and consequently fails to meet the wide individual differences still existing in the group. The disadvantage of homogeneous grouping for bright students is probably due to the factors of motivation and self-activity. In a heterogeneous group. the bright students carry on most of the activity and have a strong motive for doing so, in their desire for displaying their powers before less capable students. That bright students often learn less well in a homogeneous than in a mixed group is probably not a serious defect in view

of the fact that their achievements are still above those of average students.

The Dalton Plan. The Dalton plan is based on three principles, namely: freedom, coöperation, and economy of effort or budgeting of time. Freedom is provided for by allowing the student to decide the order in which he wishes to do his work. Provision is made for coöperation by allowing the students to learn their lessons together in a classroom or laboratory, and economy of effort is secured by permitting the student to plan each day's work. The essential features of the plan may be outlined in connection with the terms *house, laboratory, bulletin board, daily time schedule, job,* and *record of pupil's progress.* A *house* consists of all the pupils in the several grades assigned to a home room under one teacher. The *laboratory* is the room where the pupils study a particular subject. It is called a laboratory instead of a classroom because in it the students work around tables upon which are placed the various materials relating to the subject, and are free to move about and work with each other as they wish in order to get their work done. The *bulletin board* contains the announcements which the pupils are to read each morning in order to plan the day's work. The *daily time schedule* in the traditional sense is conspicuous in the Dalton plan by its absence. Since the student is allowed to plan his day's work as he wishes, although a conference with the teacher each morning is included, there evidently can be no regular schedule of activities. In practice, however, the academic subjects are studied in the morning, and the non-academic in the afternoon. A *job* consists of the assignment sheets which outline the work for the pupil for a month in advance. It is comprised of *contracts,* which contain the assignments in one subject for a period of a month; and divisions of the latter, called

units, the work to be done each day during the month. In doing the day's work, the student first holds a brief conference with the teacher and plans his work for the day, then proceeds through the various laboratories. He usually closes the day by another brief conference with a teacher. There are no recitations or failures, and there is no definite amount of time to be devoted to a given task. A pupil's progress depends upon the units of work completed, records of which are kept by the school and pupil. The plan is advantageous in that a student can work at his own speed and can avail himself of many sources of information to aid his work. It also gives him an opportunity to develop self-reliance. Among the disadvantages of the plan are its lack of opportunity for oral expression, its lack of the social stimulation which comes from classroom work, the absence of a scientifically selected curriculum, the use of a curriculum based upon authority rather than on individual needs, and the wide opportunities for wasting time and for copying from others in the laboratory.

The Winnetka Plan. The Winnetka plan is characterized by a double curriculum, individualized work in skill subjects and group work in others, goals, practice exercises, and mastery tests. The curriculum is made up of two parts—one including skill subjects such as arithmetic and spelling and the other consisting of socialized and creative activities. Approximately one-half of the school time is devoted to each. In learning the skill subjects, each pupil works alone. His work in each grade and subject is divided into a specific number of goals which have been scientifically selected by the school. The pupil's task is to master each goal. To do so he uses an exercise book containing practice materials by which he may form the habits necessary for reaching the goal. When he thinks he has learned the goal, he gives himself a diagnostic test. If he

misses parts of it, he resumes his practice and then takes another equivalent test; and so on until he is convinced that he has learned his task. After this, he takes a mastery test given by the teacher. If he passes it, he receives credit for the goal and takes up the work for the next goal. The practice materials are carefully selected and contain only matter directly related to the goal for which they have been selected. The social and creative activities include athletics, social studies, dramatics, fine arts, industrial arts, and student government. These activities are carefully directed, but each student chooses from them according to his interests and needs. He works with the group or alone, as the situation may require. As in the Dalton plan, there are no recitations or failures, and each student is allowed to progress as rapidly as his abilities permit. The only condition is that he must master each goal as he goes along. Among the advantages of this plan, from the standpoint of learning, are individual progress, obviation of necessity for relearning goals already mastered, competition with self, and an opportunity for creative work along the line of individual interests. Among its disadvantages are the failure to coördinate the two divisions of the curriculum, the absence of social stimulation in the skill subjects, and the compulsion to use socially determined rather than individually determined goals.

The Morrison Plan. The Morrison plan is characterized by five steps: exploration, presentation, assimilation, organization, and recitation. Often a sixth step: testing for mastery, is added. The purpose of the exploration period is to reveal the student's background and experiences relating to a new unit, to establish an apperceptive mass for it, to enable the teacher to discover what is or is not known about the new unit and to outline a procedure, and to arouse the pupil's interests. The presentation period

is organized to impart in a single period the major essentials of the new unit, to prepare the pupils for independent study, to clear away initial difficulties, and to establish adequate motivation. The objective of the assimilation period is to give the pupils an opportunity for systematic study of the content of the new unit. This is essentially a period of supervised study directed by the teacher and is featured by a mimeographed guide sheet which gives references to a wide assortment of materials from which the student selects according to his needs. It ends with a test upon the essential facts. The period of organization organizes the facts of the unit into a logical outline. In the recitation period, the pupils who have mastered the unit present it to the remainder of the class and to the teacher. The pupils give floor talks and written reports, hold general discussions, and sometimes debates.

This method appears favorable to learning in the following ways: the pupil discovers his deficiencies at the very beginning of a unit, and so knows on what points study should begin; the orientation enables the pupil to know what the unit is all about; the assimilation periods admits all available sources of information such as textbook, library, museum, teacher, or fellow student; there is a variety of activity so great that there should be little difficulty because of monotony and boredom; and there is a variety of modes of expression, so that the silent student as well as the talker may show his mastery of the unit. The method seems unfavorable to learning for the following reasons: there is danger that the careful plans necessary for success will not always be made; during the assimilation period there is ample opportunity for wasting time; the pupil in attacking so many sources of information may flounder in the attempt; and there may be a difficulty in securing teachers who are well enough trained

in both subject matter and in directing pupils' activities.

The Wisconsin Plan. The Wisconsin plan has as its essential feature the differentiation of the assignment, usually into three levels: one for the inferior students, which consists of the so-called minimum essentials; one for the average students, which includes all of the first level plus some work which is both more difficult and more extensive; and one for the superior students, which contains both the first and second levels plus some work which is often of a creative or research character and which is selected because of its appeal to the peculiar interest of the individual. The principal advantage of this plan lies in its provision for a convenient way of adjusting instruction to individual differences without disturbing the traditional organization of the school. It is usually combined with other plans, such as the Morrison or Dalton.

The Project Method. The foremost characteristic of the project method is purposeful activity. The purpose should be the child's own and grow out of his life situations, but if it is a purpose suggested by some one else, it should be wholeheartedly accepted by him. The selection of the purpose is followed by thinking out ways of realizing it, and the formulation of a plan which in its typical form calls for coöperative activity by a group of individuals each of whom specialized in that activity which interested him most but which inevitably made a contribution to the attainment of the goal. The most suitable activity for a project is one that results in some visible and tangible product such as a model of a boat or of the surface features of a country or a drama; but the goal may be the solution of an intellectual problem, the attainment of a skill, or the appreciation of a work of art. If the project is successful it leads the pupil to related problems or projects, the result of which is not only a widening of the

pupil's interests but also a maturing of his ability to attack other problems. It makes the pupil feel that he is at grips with reality and thus gives him that experience which is believed to have the highest educational value—real living. It also means that the activities are carried out by the spontaneous and creative efforts of the pupils, the success of which is indicated by the gradual elimination of the teacher as the project advances.

The advantages claimed for the project method are harder work, guidance, better learning, and the development of many "allied attitudes and capabilities." It is probable that most of the benefits of the project method can be explained by the motivation secured when the conditions of an ideal project are realized. The "allied attitudes and capabilities," which are for the most part by-products of the main activity, will usually not be realized, if the experiments on incidental learning and on transfer of training are to be trusted. There are other objections, such as the difficulties of putting all of the desirable content of the curriculum into the project form, the great length of time required to complete many projects, the lack of opportunity for proficient mastery of fundamental skills, the great opportunity for wasting time in finding adequate material for realizing the goal, and the frequent conflict between a logical and a psychological organization of subject matter. From the standpoint of a learning situation, there are so many factors which may turn the scales one way or the other that conclusions should be based on fine experiments rather than on fine arguments.

Other forms of unit assignments are called *long unit assignment, individual instruction, contract plan, laboratory plan, problem method,* and *socialized procedure.* The methods described by these terms, however, do not contain features essentially different from those already described.

For the most part, they are combinations of one or more of the features contained in them and are not in need of separate description.

Special classes. Special classes are formed for the purpose of meeting the needs of those students who can not be cared for adequately in the usual homogeneous groupings. They are organized both for the very dull and for the very bright, but according to Billett's study, they are nine times as frequent for the former as for the latter. The merit of the special class lies in its ability to create a favorable opportunity for meeting individual needs. Since such a class is usually small the instruction seldom has the character of group instruction, but is nearly always individual. Its success depends entirely upon the ability of the teacher and upon the adequacy of his materials and equipment. Most schools cannot supply either: this constitutes the principal disadvantage of special classes.

Advisory or guidance programs. These programs do not represent any special method of meeting individual differences. An advisory agency takes account of the individual needs, abilities, and interests, and works out the best educational program which the facilities of the school permit. The advisory agency may vary the pupil's load, it may advise courses which are fitted to his needs, or it may find a special councilor for an individual. If the school makes use of homogeneous grouping or special classes, then the advisory agency places him in the group which is most suitable for him.

The Case-Study Method. There are always some individuals who cannot be adequately taught by any so-called plan of individual instruction. Such individuals are in need of scientific study. The method for dealing with them is usually known as the case-study method. Its essential features may be discussed under three topics: the

selection of the individuals, the diagnosis of the difficulties, and the remedial treatment. The individuals selected for case study are usually so deficient or differ so widely from the average of the group that they almost select themselves. Some of their symptoms are, namely: repeated failures in the classroom, a marked disability in a particular subject, unsocial conduct, and marked deficiency in personality. The purpose of the diagnosis is to locate the exact difficulties of an individual and to find, if possible, their causes. It may be divided into two parts: obtaining the case history, and testing the individual. The case history should include the following topics: the family, the development of the individual, the sociological experiences of the individual, the physiological or health examination, educational development, and psychological development. The family record should include the main facts about his immediate family and his near relatives such as sex, race, marital status, economic status, and outstanding psychological and organic diseases. The development history of the individual should include his birth, birth injuries, height and weight at birth, age of walking, age of talking, time of appearance of the first tooth, disease history, and a record of all psychological abnormalities, such as nervousness, insomnia, emotional explosions, and all forms of abnormal behavior. The sociological record should contain an account of his social attitudes toward his family, neighbors, teachers, and companions, his group memberships, his recreational habits, and his love affairs. The educational record should include the grades that the individual passed, skipped, or repeated; the degree of achievement attained in each grade, his interest rank in the school subjects that he pursued, his classroom attitude, and his attitude outside of the classroom. The physiological and health examination

should include a record of the condition of his sense organs; nutritional status, heart condition, motor ability, structural abnormalities, and all such items as are usually included in a complete medical examination. The psychological examination should include the individual's record in an intelligence test. In addition to the above, a record should be taken of the individual's performance in a complete series of achievement tests in the field of his disability. The reason for keeping such a complete record is that a disability is rooted in the character of the individual's total development. While some items may have little relation to a particular disability, the complete record is more likely than an incomplete one to reveal the real cause. The remedial treatment usually takes the form of systematic, individualized instruction. Its purpose is to remedy the deficiencies found in an individual, and the particular remedies selected are of such character as, in the judgment of the clinician, is suitable for the purpose. Needless to say, the case-study procedure can or should be used only by one who has professional training for this type of work. Such a person usually does not give the remedial treatment, but like a physician, prescribes particular remedies to be applied either by the teacher or some other suitable person. The value of the case-study method is self-evident. Its principal disadvantage is the lack of persons trained to use it and the absence of facilities for doing this type of work.

Motivation

Learning needs a motive in the form of a goal or in the form of a drive or desire for it, or both. The drive or eagerness to achieve is the important condition, but it is seldom possible to have this eagerness without a goal. Effective motivation increases the speed of learning. This

is true of both animal and human learning. In learning experiments with animals, care is always taken to make an appeal to some strong organic need which may be satisfied by the learning of an activity. Usually this need is hunger, but it may be thirst, sex deprivation, or exploration. A satisfied animal is never a good subject for a learning experiment. He may explore or play around for a time, but invariably he does not complete the task set. Usually he lies down and takes a nap. If, however, he is deprived for twenty-four hours of food or water, he then is active and eager to explore in order to satisfy his needs. The effect of motivation and the consequent reward in animal learning is shown in an experiment by Tolman and Honzik.[21] A group of hungry rats was fed its full ration at the end of each daily run in the maze. A second hungry group did not receive any food at the end of the run, a third group was only slightly hungry but received a full meal at the end of each run, and a fourth group was slightly hungry and received no reward. The group that was hungry and fed at the end of each run decreased its errors from about 260 on the first day to about 60 on the seventeenth day. The group that was slightly hungry but well fed decreased its errors during the same time to about 180. The group that was hungry but not rewarded made almost no improvement. The group that was not hungry and not rewarded decreased its errors from 260 to 230. This experiment shows that rapid learning is favored by two conditions: strong motive and adequate reward. If either or both of these conditions are lacking, the rate of learning is much reduced. That these conditions have the same effect in human learning is shown in an experiment made by

[21] Tolman, E. C., and Honzik, C. H., "Degrees of Hunger, Reward, and Non-Reward, and Maze Learning in Rats," *University of California Publications in Psychology*, Vol. IV (1930), pp. 241–256.

Book and Norvell[22] in which different college students practiced, under motivated and unmotivated conditions, four activities: writing A's, doing simple subtraction problems, crossing out Spanish words, and multiplying mentally. Under the motivated condition, the students kept a record of their scores, were urged to improve, and asked to keep a sharp lookout for short cuts. Under the unmotivated, they simply were told to do their best but given no knowledge of their scores. In crossing out A's, the motivated group increased its average score from 58 to 76 during the first thirty practice periods, while the unmotivated group raised its score from 55 to 69. At the end of this time, the learning conditions between the two groups were interchanged, with the result that the hitherto motivated group made a large drop in its score, while the previously unmotivated group made a sudden rise. This shows that motivation accelerates the rate of learning and that the lack of it retards learning.

The reward or learning should be appropriate to the motive. If hunger is the motive appealed to in an animal, it should be rewarded with food and not water; and if thirst is the motive, it should have water and not food. If these rewards are interchanged, the result is a slowing up of the learning process. This same effect is seen in the experiment of Tolman and Honzik, referred to above, in which the reward of food had little effect when given to an animal that was only slightly hungry. In an experiment made by Elliott,[23] it was found that changing the reward from food to water for a group of rats that was slightly hungry and very thirsty, greatly accelerated the

[22] Book, W. F., and Norvell, L., "The Will to Learn: An Experimental Study of Incentives in Learning," *Pedagogical Seminary,* Vol. XXIX (1922), pp. 305-362.

[23] Elliott, M. H., "The Effect of Appropriateness of Reward, and of Complex Incentives on Maze Performance." *University of California Publications in Psychology,* Vol. IV (1929), pp. 91-98. Also "The Effect of Change of Drive on Maze Performance," *ibid.*, pp. 185-188.

speed of learning; but giving water to a group that was only slightly thirsty but very hungry retarded the rate of learning. The same is true to some extent of humans. In an experiment of Thorndike's,[24] individuals were required to select by number a certain card that contained a quotation about a particular topic, such as death or roses. Later the numbers were repeated and the individual was required to respond by naming the topics written upon the card. It was found that correct responses that were followed by the announcement "right" were repeated in 54.3 percent of the cases; if the announcement was less definite, such as "good," "very good," or "fine," the correct responses were repeated in only 34.6 percent of the cases; while if there was no announcement, they were repeated in only 27.7 percent of the cases. This indicates that the more specific the reward with respect to the ends sought by the learner, the more effective it is in producing improvement.

The effectiveness of the reward is also influenced by its time relationship to the learning activity. In animals and children, the more immediate is the reward, the more effective it is. In an experiment by Warden and Diamond,[25] it was found that if punishment followed the wrong turn immediately, the correct turn was learned in 37.8 trials. If it was delayed eight seconds, the learning of the correct turn required 71.5 trials; and if it was delayed twenty seconds, the learning necessitated 108.0 attempts. Brenner [26] found similar results for children in the case of reward by praise. Immediate praise was found

[24] Thorndike, E. L., *The Psychology of Wants, Interests, and Attitudes*. New York: D. Appleton-Century Company, Inc., 1935.

[25] Warden, C. J., and Haas, E. L., "The Relative Value of Reward and Punishment in the Formation of a Visual Discrimination Habit in the White Rat," *Journal of Comparative Psychology*, Vol. VII (1927), pp. 117–127.

[26] Brenner, Benjamin, "Effect of Immediate and Delayed Praise and Blame upon Learning and Recall," *Contributions to Education*, No. 620. New York: Teachers College, Columbia University, 1934.

to be more effective for third-grade children in learning spelling than delayed praise or no praise. On the other hand, delayed blame seemed to be almost as effective as immediate blame.

The effectiveness of reward is also related to its amount. Grindley [27] found that chicks that were fed six grains for each successful trial in running down a certain passageway, learned more rapidly and reached a higher achievement than a similar group fed only two grains. Within limits this is also true of humans. Thorndike [28] and Forlano discovered that in the case of boys ten to sixteen years old, money rewards in addition to the announcement "right" had some effect in increasing the amount of learning. They concluded that under the condition of the experiment, money rewards up to four tenths of a cent for each success increased the rate of learning; but increasing it up to eight tenths of a cent seemed to do more harm than good. The essential reward seemed to be the knowledge that the effort made was a success.

The foregoing experiments indicate that the effectiveness of a motive depends upon its strength and also upon its appropriateness and amount. They also indicate that there are some essential differences in motives between animals and humans. In animals the motives are principally organic in nature, but in humans the motives, as well as the rewards, may be purely intellectual. This does not mean that the humans are lacking in organic motives nor that the intellectual motives used in learning are unrelated to organic needs, but it does indicate that humans may have motives which are only slightly related to or-

[27] Grindley, G. C., "Experiments on the Influence of the Amount of Reward in Learning in Young Chickens," *British Journal of Psychology*, Vol. XX (1929), pp. 173–180.

[28] *Loc. cit.*

ganic needs. The motives referred to in the experiments relating to humans involve principally intellectual ones, or knowledge of results. Some other types of psychological motives and rewards that have been found effective in human learning are emotional and social in character. They may be even purely esthetic, although no experiments are available to show the effectiveness of motives falling in this group. Although human motives are intellectual and emotional, social or psychological, they have in common with animal motives the fact that they relate to an individual's needs. It is very important to keep this in mind in the management of learning activities. If learning is to be effective, it must meet some need in the learner.

Extrinsic Motives

Human motives may be either *extrinsic* or *intrinsic*. Extrinsic motives are those not inherent in, but external to, the activities, such as the desire for success (which may be rewarded by knowledge of success), praise, blame, or some material reward. On the other hand, the learning activity has an intrinsic motive when the activity is desired for its own sake. Theoretically the intrinsic motive is the ideal one, but it usually must be acquired and does not become effective until an activity reaches a high degree of mastery. Before the learning reaches this stage, it is usually affected by extrinsic motives, which, therefore, play a very important role in the management of the learning process. For purposes of discussion, extrinsic motives may be divided into two classes: *mastery motives* and *social motives*.

Mastery motives. Mastery motives are satisfied principally by knowledge of results. Reference has already

been made to the experiment of Book and Norvell [29] which showed the effect of knowledge of results on learning. Knowledge of results or knowledge of improvement may be used to motivate any type of learning. The experiment of Book and Norvell showed that it was effective for writing A's, subtraction, mental multiplication, and canceling words. An experiment by Chapman and Feder [30] showed that it was effective for addition. One by Arps [31] showed that it was effective for increasing the amount of muscular work, as demonstrated in the case of pulling the weight over a pulley with a finger. An experiment made by the writer showed its effectiveness for motivating such drawing activities as are required in making lines, rectangles, and circles. Certain experiments of Thorndike [32] show very clearly the effect of knowledge of results on learning. In one of these experiments, six subjects estimated the length of lines varying from 3 to 27 centimeters when a ten-centimeter line was shown as a standard. In an experiment divided into seven training periods, the average amount of error at the end of the experiment, when no knowledge of right or wrong was given, was 7 percent greater than at the beginning. When knowledge of right or wrong was given, the reduction of error between the end and the beginning of the training period was 61 percent. Similar results were found in a repetition of this experiment by Abelson. In another experiment, subjects tossed balls backwards over their shoulders to hit a certain target placed on a table behind them. One group was given knowledge of right and wrong

[29] *Loc. cit.*

[30] Chapman, J. C., and Feder, R. B., "The Effect of External Incentives on Improvement," *Journal of Educational Psychology*, Vol. VIII (1917), pp. 469–474.

[31] Arps, G. F., "A Preliminary Report on Work with Knowledge of Results *vs.* Work without Knowledge of Results," *Psychological Review*, Vol. XXIV (1917).

[32] *Loc. cit.*

of its scores, while another equal group was given no such information. The group that was aided by knowledge of results made 218 percent more improvement than the unaided group, the learning periods for the two groups being the same.

Social motives. Experiments show that appeals to social motives are effective in learning. One of the best known is an experiment made by Hurlock [33] on the effectiveness of praise and blame on the learning of arithmetic. The praised group learned far more than the blamed group, although the use of either was more effective than no praise or blame at all. In an experiment made by Sims,[34] in which the comparative value of individual and group motivation was tested for learning substitution and for increasing the rate of reading, it was found that the pupils having group motivation improved more than those who had no motivation, and that the individually motivated pupils improved more than the group-motivated. The relative values of no motivation, group motivation, and individual motivation, in case of substitution, were 102, 109, and 157.7, respectively. Maller [35] found similar results for improving skill in addition. In his experiment, the children worked under three conditions: first, doing problems as a matter of practice without any knowledge of scores; second, doing the same when they received knowledge of scores and competed with themselves; and third, when the competition was between groups. The results showed that competition with self

[33] Hurlock, E. B., "An Evaluation of Certain Incentives Used in School Work," *Journal of Educational Psychology*, Vol. XVI (1923), pp. 145–159.

[34] Sims, V. M., "The Relative Influence of Two Types of Motivation on Improvement," *Journal of Educational Psychology*, Vol. XIX (1919), pp. 480–484.

[35] Maller, J. B., "Coöperation and Competition," *Teachers College Contributions to Education*, No. 384. New York: Teachers College, Columbia University, 1928.

was the most effective. The average child did 32.4 more examples in twelve minutes when working against his own record than when attempting to defeat the record of the rival group.

Intrinsic Motives

The most important efforts to motivate learning by intrinsic motives have been made in the fields of literature and science. In both, extensive studies have been made of children's and adults' interests with the idea of either selecting or creating material which would make a direct appeal to these interests. Curriculum makers, after making surveys of the interests of the learners, have made systematic efforts to find materials that would satisfy them. In the cases of reading and literature, numerous studies have been made to find the actual selections which have the greatest interest for a certain age and sex. Similar but less extensive efforts have been made in science. In reading, it has been found that students do much when they have an opportunity to use selections that interest them, but as little as possible when this requirement is not satisfied. The principle criticism by English teachers of this type of reading is that the children often read the wrong kind of material. At any rate, they do not read what the teacher thinks they ought to read. If improvement in reading is measured by the amount of material read, there is no doubt of the advantage of making appeals to intrinsic interests. If it is measured by the quality of the material read, there is room for considerable doubt. Studies of the voluntary readings of high-school students indicate that there is an immense advantage in selecting materials that are worthwhile in themselves or which have an intrinsic interest for the learner. Thorndike [36] has measured the effect of such materials on learn-

[36] *Loc. cit.*

ing. He made experiments in which individuals were required to learn the birth years of celebrities in literature, art, science, and statesmanship, and other fields of human endeavor; and also the birth years of nonentities such as laborers, tradesmen, farmers, etc.; the true meanings of certain rare words and the false meanings of certain words; materials from the Bible, *Book of Mormon,* and *Golden Bough* and true and false biographies of famous persons. He found that the useful information remembered about celebrities and nonentities was from 2.7 to 3.6 times as great as the useless. The ratio of the retention of celebrities' dates to those of nonentities was 1.04, which indicates very little difference; but the ratio of knowledge of correct to knowledge of wrong meanings of words was 1.57, which appears significant. The results showed, however, that the false biographies were better learned and retained than the true ones. This last is probably not the result of the falsity of the information, but of the greater vividness in the false biographies and the astonishing qualities of imagination expressed in them. Disregarding the results on the biographies, Thorndike's results indicate that useful and true information is learned more thoroughly and retained longer than useless and false information, although in some cases the latter may have qualities which would contradict this statement. If we accept this as a general rule, it is worthwhile from the standpoint of learning that great care be taken to select useful and truthful material for educational purposes. Or we may say, in other words, that one of the most effective methods of motivating learning activities is the selection of useful content. Such an endeavor is valuable both psychologically and sociologically—psychologically because it intensifies learning and sociologically because it promotes good citizenship.

Summary

The psychology of secondary-school subjects is the science of the activities by which these subjects are learned, and of all the factors that influence them.

The learning process involves three major phases: a goal, a method, and a content—all of which must be studied with reference to each subject.

The methods of learning school subjects may be discussed under four principles, namely: organization, practice, individual differences, and motivation. Organization emphasizes the study of relationships, which give meaning, unity, coherence, and system to the facts. Practice is an activity resulting in improvement through repeated efforts to do better. The principle of individual differences refers to those deviations of an individual from the average of his group which must be considered in teaching him effectively. The principle of motivation is concerned with those needs of an individual which add zest and intensity of effort to learning.

The perception of pattern or organization in a group of facts increases the number of facts that can be grasped in one act of thought, the rate of learning, the amount of retention, and the facility for transferring skill from one activity to another. It therefore contains the secret of economical learning, and has numerous applications to learning.

Practice adds facility, accuracy, speed, and not infrequently meaning to a response. To practice effectively, a learner should know the goal of his efforts, have an idea of the method of attack, have a knowledge of the results, and have frequent measures of his progress.

The amount of improvement derived from practice depends upon the following factors:

Distribution in time. Within certain limits, the more

distributed is the effort, the more rapid the improvement.

Distribution in space. For most individuals, the part-progressive method is the most economical, but for others the part or whole method is more satisfactory.

Distribution according to difficulty of task. The more difficult a task is, the more effort should be given to it.

Intensity of effort. Vigorous effort is more effective than mild effort.

Guidance. Guidance should be given early in the learning, limited in amount, and usually verbal in form.

Sensory avenue. Use the sensory mode which gives the learner the clearest idea.

Application at the point of error. Effort should be expended on correcting errors.

Application to real activities. Learn an activity as it is used in life situations.

Application to useful activities. Learn activities that are useful to the individual and to society.

Differences between individuals in the same grade are far greater than differences between the averages of grades themselves, but in spite of this, the instruction is patterned according to the latter rather than the former.

Individual differences are due to both hereditary and environmental factors.

Plans for adjusting instruction to individual differences attempt to socialize the individual and to prepare him for self-maintenance in a social order by allowing (1) variations in rate of learning, (2) variations in quantity of material, (3) variations in quality of material, and (4) combinations of the above. Among the better known plans are homogeneous grouping, the Dalton plan, the Winnetka plan, the Morrison plan, the differentiated-assignment or the Wisconsin plan, the project or problem method, special classes, and the case-study method. Each plan has its

special features, but the first three emphasize provisions for variations in rate of learning; the next three, provisions for variations in quantity and quality of the tasks; and the final two, combinations best suited to the individual.

Learning needs a motive in the form of a drive or a goal or both. Effective motivation increases the speed of learning. The effectiveness of the reward depends upon its appropriateness to the motive, its time relationships to the completion of the task, and its amount.

Motives may be either extrinsic or intrinsic. The extrinsic ones are not inherent in the learning of the activity but are directed to its result. The intrinsic are inherent in the activity, which is desired for its own sake. They are usually the products of mastery. While that is being reached, learning is usually encouraged by extrinsic motives, such as mastery and social ambitions. Experiments show that both may be used to speed up the learning process. Theoretically, intrinsic motives are the ideal type. So far, the most important efforts to use them have been made in the fields of literature and science.

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CHAPTER 2

English Composition: Objectives and Organization

The primary aim of teaching English composition is to develop clear expression of thought in speech and writing. There are occasional forms of composition in which the objective is to express feeling, emotion, or beauty. In such cases, the clear expression of thought becomes secondary; but with these exceptions, it is the purpose of speech and of writing. Composition is aided by good organization, correct form and sequence, and well-selected words. Consequently, in any course in English composition considerable time must be devoted to these phases; however, they should never become the major objectives of study. They are valuable only insofar as they are important vehicles of expression.

The primary purpose of written composition is the clear expression of thought in the most commonly used forms of writing. Among these are notes, letters, summaries, outlines, reports, explanations, expositions, and narrative. There is also a form which may be called creative writing, which has for its major purpose the expression of some esthetic qualities. Such composition should be encouraged only for those who are qualified and interested. The ability to write composition is aided by familiarity with logical outline, paragraph organization, sentence mastery, spelling, capitalization, and punctuation; knowledge of grammar and an extensive vocabulary; and legible writing. Consequently, all these topics should be studied in order

to acquire control of the art of writing. But, again, they are important only insofar as they are related directly to the expression of thought. To study such topics as ends in themselves is to miss their purpose.

The fundamental purpose of speech is the clear expression of such thought as is required to meet the needs of daily life, such as making known bodily wants, saying well what is necessary to say in shopping, taking and delivering a message, telephoning, answering and asking questions, conversing agreeably, speaking courteously, expressing thought and feeling in oral reading, speaking informally to a group, conducting a public meeting, and speaking to an audience. Some of these, such as the last two mentioned, are much less important than the ability to speak courteously and should be developed only by those qualified and interested. Effective speaking is aided by correct pronunciation and enunciation, voice control, poise, and idiomatic expression. Each of these topics, to the extent that it is related to the communication of thought, should be developed.

Classification of Methods

The methods of learning composition may be discussed under the major principles of learning, which we have called organization, practice, motivation, and individual differences. Under organization we shall discuss those methods of composition which emphasize the understanding of the correct patterns, forms, and principles of language. Under practice we shall discuss the methods of drill which have been effective in developing correct habits of speech and writing and in eliminating incorrect forms. Under motivation we shall discuss the methods of appealing to those interests which have been found effective in producing a high quality of composition. Under indi-

vidual differences we shall discuss those factors and difficulties which must be regarded in the individual in order to develop effective language habits.

Methods Relating to Understanding of Forms

Developing a pattern of thought. Possibly the first requirement in writing a composition is the development of a pattern of thought, consisting of units each of which has its characteristic theme. The unit begins somewhere, ends somewhere, and has a certain inherent unity all its own. The first lesson in composition might very well be devoted to training in the recognition of such units. After the pupil has such a unit, he should see in it a pattern consisting of certain centers around which cluster the more specialized ideas. That is, the unit differentiates into an organization, which may be either simple or complex, and which distinguishes a composition from a series of rambling thoughts. The perception of a pattern is probably the best preventive of such thoughts.

Teaching Pupils to Perceive a Pattern of Thought

That students can be taught to perceive a pattern of thought has been shown in Lyman's[1] experiment in the use of diagrams. It was conducted in coöperation with 31 teachers and 1,039 pupils from Grades VI, VII, VIII, and IX in twenty junior high schools and eleven elementary schools in Chicago and vicinity. Although the experiment lasted only seven weeks, the pupils made very noticeable gains during that time. Lyman's class procedure was to assign a topic on Monday and work out a plan in the form of a diagram. On Tuesday each pupil, using his own plan, wrote the first draft of his composition and strove to ex-

[1] Lyman, R. L., "Coöperative Experiment in Junior High-School Composition," *School Review*, Vol. XXXIX (1931), pp. 748–754.

press himself as freely and as fully as possible. On Wednesday he carefully examined his first draft, attempted to discover and correct his errors, and made any other changes which he believed would improve his composition. On Thursday each pupil copied his composition, observed his own corrections, and placed the finished product in the class portfolio. Diagrams taught were the chain, a train of cars, a house, and a hand. The parts of each diagram represented different phases or paragraphs in a topic. For example, on the topic, "The Ford is a Good Car," a chain diagram was used. It was as follows:

It's cheap	—	It always goes	—	It is easy to drive

Similarly, in the diagram of the hand, the thumb and fingers each represented a point to be developed in the composition. In the correction of errors, the teachers gave help only for the first composition. The gains during the seven weeks were measured by the reduction in errors and improvement in quality as measured by the Wisconsin Scale. The number of errors per hundred words in different classes was reduced by 40 to 75 percent and the quality of the writing was improved by an amount which varied from almost 0 to 0.5 of a step. The latter gain was made by Grade VI and represents a little more than standard gain for one year. Although this experiment was too short to establish conclusions, the fine improvement made in such a short time shows that this type of supervision is worth trying.

Developing the idea of the correct sentence and giving exercises in self-correction. After the pupil sees the outline of his thought, he must give it concrete expression through sentences. This requires the mastery of the sentence. Possibly the failure of many pupils to write a

good sentence lies in their ignorance of what a good sentence is. This may be expected to be the usual condition in the primary grades; but it is by no means limited to the grades, for it occurs with surprising frequency among college freshmen. What a good sentence is may be taught by the presentation of models, and exercises in the self-correction of wrong sentences. Such a procedure was found to be effective in an experiment by Price,[2] who used three experimental classes and six control classes from Grades VII and VIII. The procedures used in the experimental classes were the reading at appropriate intervals of models, which the pupils copied from dictation, and the correction by the pupils of errors in sentences from their own compositions. For use in correcting the sentences the pupils were given a few models to be imitated and the following directions: (1) Note all the ideas the writer has expressed. (2) See how the correct sentence differs from the incorrect and find the simplest way to express the thought. (3) Retain every thought of the writer. (4) Cut out everything unnecessary to the understanding of the thought. (5) Put the thought into one, two, or three sentences and make sure that they are all correct. (6) Do not ask for help until necessary. (7) Have two other class members criticize corrections.

The procedures used in the control classes were similar to those in the experimental classes only in that models were read to them and compositions were written in imitation of these models. They differed in that the control pupils had no dictation, their errors were marked in red ink by the teacher and they lacked the practice in the synthetic development of sentence structure.

[2] Price, Edwin, *A Study in the Evaluation, Frequency of Occurrence, and Method in the Elimination of Sentence Errors Among Junior High Students.* Master's Thesis, Department of Education, Leland Stanford Junior University, 1923.

Four initial test compositions were given to all the pupils at the beginning of the experiment and two at the end, all of which were measured by both the Hudelson and the Willing scales. The latter showed a reduction in number of errors per 100 words from 5.4 to 1.7 between the first and last tests for experimental class No. 7–1. This may be compared with a reduction from 3.6 to 3.1 for an equivalent control class No. 8–1, for the same period. Comparable results were obtained in the other experimental and control classes.

Some factors that may account for the superiority of the experimental procedure are that the models gave the pupils a definite goal to be reached, and that the exercises in self-correction forced them to attain it through their own thinking.

Developing patterns of thought out of the individual's experiences. Inasmuch as the object of teaching composition is to train the individual to express his own thoughts rather than another's, it is important that each individual should learn to organize his own experiences into patterns of thought. Most of the experiences of an individual can be so organized, but it is necessary for the pupil to see that this is possible.

Pupils may be assisted in forming patterns by individual instruction. An experiment made by Heckert [8] shows how such a procedure may be effectively used. To demonstrate its value, Heckert used two classes, balanced as to intelligence, for twenty-five periods of one hour each. The pupils in the experimental class received help in how to choose a subject, how to plan and arrange materials, and how to make an outline. Much emphasis was placed on having something to write about. The details are il-

[8] Heckert, J. W., "The Effects of Supervised Study in English Composition," *Journal of Educational Research,* Vol. V (1922), pp. 368–380.

lustrated in Heckert's instruction of a boy who chose as his subject, "Mischievous Billy." He had been taught to make an outline, but his outline did not indicate what he planned to say. When asked about the matter, he replied, "I am going to tell how Billy went uptown, and a lady asked him, 'How do you do Billy?' and Billy said, 'I do as I please.'" His teacher objected to this as a composition. By further questioning, the teacher discovered that the boy had a playmate in his neighborhood who might be called, "mischievous Billy." This playmate found a coaster wagon and a can of paint and proceeded to paint the wagon—getting considerable paint on himself. Other incidents suitable to include in this topic were some relating how older children punished the naughty playmate by throwing basins of water on him, and how two boys tied a tin can to a bantam rooster's tail and convulsed the children of the neighborhood with laughter. After these incidents were recalled, the following outline was suggested: (1) Billy has some fun with his rooster. (2) Billy paints a wagon, but also himself. (3) Billy receives a bath. (4) Billy has a settlement with his mother. In the development of each topic, he was asked to imagine the things that might have happened, and if suitable, to include these in the paragraph relating to the topic. The improvement yielded by this procedure is shown in the first paragraph written by this boy in the final test given at the end of the experimental period: "It was one dismally sultry, rainy day last summer in Wisconsin. It had been raining hard all night before, and of course everything was covered with water. The roads were bad all around the hill, but none as bad as the newly made dirt road coming down the hill." Although this paragraph is still faulty, it shows considerable improvement over the boy's first composition.

Presenting patterns in effective form. The effectiveness of a model depends upon its mode of presentation. It may be presented in many forms, for example: through the oral reading of the model by the teacher, or its silent reading by the pupils, either method with or without discussion. The effectiveness of such procedures was the problem of an experiment made by Perry.[4] Her methods of presentation were evaluated by comparing the number of valueless sentences, valuable sentences, repeated beginnings, illogical placings, informational items, and number of words and errors in the experimental and in the control classes. Although these methods contained a number of subjective elements, they showed that presentation of a model composition with discussion was superior to presentation without discussion, that the oral reading of a model by the teacher to the pupils was superior to its silent reading by the pupils, and that the reading of a narrative to the pupils by the teacher without discussion was superior to its silent reading by the pupils without discussion. Presentation with discussion was probably superior to presentation without discussion because the latter brought out certain characteristics of the model that were otherwise unperceived. The oral reading by the teacher was probably superior to the silent reading by the pupils because the teacher's expression conveyed the thought. That is, the method that proved to be superior was the one that led to a better understanding.

Presenting the desirable qualities of a model, if known. If a well-understood model is superior to a poorly understood one, then it follows that a pupil should understand all those qualities of a form of composition which make it superior. It should be helpful if we had a list of

[4] Perry, Anna Russel, *An Experimental Study of Certain Problems in English Composition.* Master's Thesis, University of Pittsburgh, 1927.

the desirable qualities to be expressed in each form of composition, including letters, poetry, the many types of prose, and the various forms of all compositions. Some work along this line has been done by Johnson,[5] who has studied the desirable qualities of letters, of good conversation, and of group discussion. In his investigation of the desirable qualities of letters over 1200 letters were used. Of these, 150 were contributed by women of recognized leadership and 1000 by young women of approximately college-freshman standing. A number were taken from literary collections, and a fourth group was contributed by outstanding business men. Johnson's procedure was to divide the letters into "good" and "bad" groups and then to analyze the qualities possessed by one half or more of the "good" letters. In the case of the "good" social letters, he found the requisite qualities to be courtesy, informality, humor, opinion, optimism, and a few well-defined centers of organization. A significant part of the study was the analysis of the devices by which these qualities were expressed. For example, letters were considered courteous if they (1) gave due attention to the salient points in the letter which was being answered, (2) never failed to express expected congratulations, (3) never failed to acknowledge obligations and showed a sense of gratitude, and (4) expressed good wishes.

In investigating the qualities of a good conversationalist, Johnson[6] interviewed a number of people for the purpose of finding out what conversational traits were considered most desirable. From those given, a list of fifty-four traits was made up and submitted to seventy-

[5] Johnson, Roy Ivan, "Letter Writing: A Curriculum Study in English Composition," *Journal of Educational Research*, Vol. VI (1922), pp. 423–437.

[6] Johnson, Roy Ivan, "Determining Standards in English Composition," *School Review*, Vol. XXXVI (1928), pp. 757–767; Vol. XXXVII (1929), pp. 44–48.

nine judges, who rated them in order of merit. The twenty traits that ranked highest in the list were: (1) ability to think clearly, (2) ability to use English effectively, (3) sense of humor, (4) ability to speak to the point, (5) ability to discuss without arguing, (6) attentiveness, (7) ability to stimulate others to talk, (8) ability to discover common interests, (9) good judgment, (10) ability to describe, (11) tact, (12) strong, deep convictions, (13) wide range of interest, (14) originality, (15) good memory, (16) broad-mindedness, (17) general educational training, (18) quick-mindedness, (19) adaptability, and (20) sincerity.

In a similar manner, the desirable qualities of the leader in a round-table discussion were found to be (1) skill in directing the discussion, (2) good understanding of the subject, (3) fairness, (4) ability to secure participation, (5) firmness, (6) knowledge of parliamentary rules, (7) tact, (8) modesty, (9) ability to speak concisely, (10) self control, and (11) courtesy.

These analyses may be used in learning to acquire skill in letter writing and in conversation. So far as the writer knows, their effectiveness for such purposes has not yet been demonstrated in an experiment, but such an attempt would be very worth while. There is also great need for other studies which would show the essential qualities of good prose and poetry. A knowledge of their qualities and of the methods of expressing them should be helpful in preventing much blind effort in writing.

Methods Relating to the Understanding of the Principles of Language

The secret of using good English was at one time believed to lie in an understanding of grammar. This view is now much less widely held but it still has many follow-

ers. According to a survey made by Smith,[7] teachers hold the principal values of the study of grammar to be that (1) it increases the pupil's ability to use the sentence as a unit of expression, (2) it makes correct usage habitual, (3) it helps pupils recognize and use correctly the parts of speech, (4) it stimulates pupils to take pride in improving their speech and writing, (5) it lays a foundation for correct punctuation, and (6) it furnishes the pupils a standard for correcting their own English. No one would dispute the value of the study of grammar if it accomplished these aims or even if it fully accomplished one of them. But the investigations which have been made so far of the influence of the study of grammar on correct English usage, lead one to conclude that none of these aims is accomplished. In fact, we may say that the study of grammar has little or no influence on correct usage. This conclusion is justified by the experiments of Asker,[8] Briggs,[9] Hoyt,[10] Starch,[11] and Segal and Barr.[12] It is worth while to analyze some of the data on which this conclusion is based.

Briggs did not investigate the direct relation between knowledge of grammar and ability to use English, but rather the broader claim that the study of grammar increases one's reasoning power. Briggs employed fifty-four tests to measure the specific abilities that are supposed to

[7] Smith, Dora V., *Instruction in English,* Bulletin No. 17, 1932. Office of Education, Washington, D. C.

[8] Asker, William, "Does Knowledge of Formal Grammar Function?" *School and Society,* Vol. XVII (1923), pp. 109–111.

[9] Briggs, Thomas H., "Formal English Grammar as a Discipline," *Teachers College Record,* Vol. XIV (1913), pp. 243–251.

[10] Hoyt, Franklin S., "The Place of Grammar in the Elementary Curriculum," *Teachers College Record,* Vol. VII (1906), pp. 467–500.

[11] Starch, Daniel, *Educational Psychology,* Chapter XIV. New York: The Macmillan Company, 1929.

[12] Segal, David, and Barr, Nora R., "Relation of Achievement in Formal Grammar to Achievement in Applied Grammar," *Journal of Educational Research,* Vol. XIV (1926), pp. 401–402.

be developed by the study of grammar. He gave these at the beginning, middle, and end of a period of six months to two classes of pupils who studied grammar and language during that time. He concluded that none of the gains could be attributed to the amount of training received in formal grammar. In other words, the study of grammar is no better than the study of composition and language for the purpose of increasing the reasoning power of the student. Hoyt, Starch, Asker, and Segal and Barr investigated the relationship between knowledge of grammar and ability to use English. Hoyt tested the grammatical knowledge and the ability in composition of two hundred high-school pupils. The correlations between grammar and composition were found to be so low as to indicate that knowledge of grammar has very little to do with ability to use English. Starch found that a year's study of Latin made a comparatively large increase in knowledge of grammar but a barely perceptible difference in the ability to use English.

Asker gave Starch's Grammatical Scale A for the Correctness of Sentences and Starch's three tests of grammar to two hundred and ninety-five college freshmen. He also secured their grades in English composition and their average grades in all subjects during the freshman year. He concluded that time spent upon formal grammar in the elementary school is wasted as far as the majority of students are concerned, and that teachers of English composition must seek some other reason for the generally poor ability alleged to prevail in this subject than the neglect of formal grammar in the grade school.

Segal and Barr investigated the relationship between formal and applied grammar. Correlations calculated between formal and applied grammar and between the grades made in various high-school subjects showed that

formal grammar is no more closely related to applied grammar than it is to other high-school subjects, or than the latter are to each other. They concluded that formal grammar had no transfer value to applied grammar.

These studies constitute a serious indictment against the teaching of formal grammar. They do not show that grammar cannot be taught so as to be useful in composition, but they do show that, as ordinarily taught, it fails to give the help that is expected from it. Theoretically, it seems that the teaching of formal grammar would increase ability in composition if it were accompanied by much practice in its application and if it consisted of materials related to writing and speech. Such grammar would at least give one a basis for criticizing his own language habits. For example, the expression, "I remember him coming to town," is grammatically incorrect. A person who knows grammar can tell why it is incorrect and, it would seem, can train himself to avoid such an expression far more easily than one who doesn't know grammar. This illustration, however, shows only the possibilities of grammar. It does not show what the actual results are. The task of making out a theoretical case for grammar is far easier than proving its usefulness. An experiment indicating that the study of grammar may be useful for improving ability in composition has been made by Symonds.[13] In his experiment the comparative value of each of the following procedures was sought:

1. Repeating only the correct forms.
2. Repeating both correct and incorrect forms in parallel columns with clear designation of right and wrong.
3. Teaching definitions, rules, and principles of grammar governing the usage of certain forms.

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[13] Symonds, Percival M., "Practice Versus Grammar in the Learning of Correct Language Usage," *Journal of Educational Psychology,* Vol. XXII (1931), pp. 81–95.

4. Teaching grammatical analysis. The pupils were asked to read definitions and examples of the principles of grammar and then required to do exercises in which they were expected to recognize and name the grammatical construction.

5. Choosing correct constructions. After reading the definitions and examples of the principles of grammar, the pupils were given practice in choosing correct constructions, such as filling in blanks with the words *most* or *almost*.

6. Practicing the whole program. This included the teaching of grammar, practice in recognizing and naming constructions, and practice in repeating right and wrong forms as in procedure 2.

The above procedures were tried out on pupils from Grade VI in the public schools of New York City. Before and after the experimental period the pupils were given a test in the use of adjectives, adverbs, prepositions, and conjunctions modeled after Charter's Diagnostic Language Tests.

The results showed that the teaching of grammar, combined with practice in right and wrong forms, was the most effective. The next best was practice with right and wrong forms without any grammar. The gains from this procedure were twice as large as from instruction in grammar alone. The mere repetition of correct forms proved to be futile. Symonds concluded that it was the quality of drill or practice that counted and not its amount, and that instead of increasing the amount of drill in school subjects, more attention should be paid to the nature of the drill. In this experiment Symonds has shown the possibility of making instruction in grammar profitable by applying it immediately to the formation of language habits and by designating clearly the right and wrong forms; failure to do this may be the cause of the poor results achieved in the past. Further researches should be made, however, to establish this hypothesis.

The reasons for the failure of grammar to help increase

the use of good English may be, as suggested, that the study of grammar is not accompanied by sufficient practice, or that the right sort of grammar is not studied, or that knowledge in itself does not form a habit of action. The last explanation is probably the most important. Few of those who study grammar know the difference between science and art. Grammar is the science of language, but the use of language is an art or a habit of action. Knowledge may lead to action but it does not guarantee it. Before it can guarantee a habit of action, the habit must be established by sufficient practice. When a person is required to speak or write, he has no time to ponder over principles of correct forms, but must say what he wishes to say.

In view of the meager results obtained from the teaching of grammar, it appears advisable to consider substitutes. Crawford and Royer[14] found oral drill at the seventh-grade level as effective in the elimination of error as the study of grammar. Clark,[15] from a study of college-freshman English during a period of four years, found that a study of reading selections with primary emphasis on thought and secondary emphasis on structure yielded greater gains in quality of composition than a course emphasizing mechanics and grammar. During the first two years, when the study of grammar and mechanics of English was emphasized, the total gains in spelling, punctuation, grammar, and diction were 50.68 and 42.63, respectively. During the last two years, when getting the thought from reading selections was emphasized, the corresponding gains were 53.75 and 79.20.

[14] Crawford, Claude C., and Royer, Madie M., "Oral Drill versus Grammar Study," *Elementary School Journal*, Vol. XXVI (1936), pp. 116–119.

[15] Clark, J. D., "A Four Year Study of Freshmen English," *English Journal* (Col. Ed.), Vol. XXIV (1935), pp. 403–410.

Summary

The primary aim of the study of English composition is the development of clear expression of thought in speech and in writing; the aim of written composition is the clear expression of thought in the most frequent forms of writing, such as notes, letters, and summaries; and that of speech is the clear expression of such thought as is required in the needs of daily life: expressing wants, saying well what is necessary in shopping, taking and delivering a message, telephoning, answering and asking questions, and so on.

All composition is aided by good organization, correct form and sequence, and well-selected words. English composition is aided by skilled habits in logical outlining, paragraph organization, sentence structure, spelling, capitalization, punctuation, and legible writing. Speech is aided by skilled habits in pronunciation and enunciation, voice control, breathing control, poise, and idiomatic expression.

The methods of learning composition may be classified according to the principles of learning, namely: organization, practice, motivation, and individual differences. Methods relating to the principle of organization that have been found effective for the mastery of English composition are the following:

1. Development of a pattern of thought.
2. Development of the idea of the correct sentence and use of exercises in the self-correction of errors.
3. Development of patterns of thought out of the individual's experiences.
4. Presentation of patterns of thought in an effective form.
5. Presentation of the desirable qualities of a pattern.

In letter-writing the desirable qualities are courtesy, informality, humor, optimism, and organization around

a few well-defined centers. In good conversation they are ability to think clearly and to use English effectively, sense of humor, ability to speak to the point, ability to discuss without arguing, and others. In leading a round-table discussion they are skill in directing the discussion, good understanding of the subject, fairness, ability to secure participation, firmness, and so on.

Many teachers still hold that the study of grammar has much value for improving the use of language. But most of the studies that have been made of the value of grammar show that this is not true. The experiment by Symonds, however, is an exception. It indicates that there is value in the study of grammar if it is accompanied by much practice. Further studies should be made to confirm this view.

Reasons for the failure of the study of grammar are found in the lack of sufficient practice to accompany the study of the subject; in the fact that the right sort of grammar may not be taught; and in the wide difference between science and art.

Knowledge of form appears to be far more important in improving language habits than knowledge of the structure of language.

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CHAPTER 3

English Composition: Practice

It has been shown that there is little or no learning from blind practice. But when practice is combined with knowledge of the results and of the approach to the goal, then it is very profitable. In agreement with this principle, practice has an important place in the formation of language habits. First the pupil should know what he wants to say and perceive a pattern in his thought, after which he needs practice to make it possible for him to express his thoughts in the correct form. If such a procedure is followed, then practice is never blind, and according to the principles of learning, it should enable the pupil to achieve his goal. That it does so is shown in many experiments, some of which we shall now discuss.

Improving the Quality of Language by Drills in Correct Usage

Drills in correct usage produce more gain in the quality of composition than the traditional method of red-inking themes, which are handed back to the pupils for correction. This was the principal conclusion drawn from an experiment conducted by Norton[1] with classes from Grade IX for a period of ten weeks, at the beginning and end of which the themes of the pupils were measured by the Hudelson scale. Group *A* received drill in correct usage; Group *B* received the same drills and also was required to revise its themes in accordance with the errors marked; and Group *C* received only the traditional teach-

[1] Norton, Cecile I., *The Value of Theme-Correcting in High School Composition Classes.* Master's Thesis, School of Education, University of Southern California, 1924.

ing in theme-correcting. The drills used in Groups *A* and *B* consisted of exercises in correct pronoun forms, correct verb forms, spelling of troublesome words, correct use of commas, and correction of sentence errors. Each group wrote one theme a week. Those of Group *A* were graded, but no corrections were made and no errors were marked. The results showed that drill and theme revision combined produced the greatest gain—a standard year's gain in ten weeks; the drill method alone produced the second largest gain; and theme revision, none at all. The experiment suggests that the many weary hours spent by English teachers in correcting themes might very well be saved without any loss in improvement by pupils, provided they receive in the classroom adequate drill in correct usage.

Formal Drills for the Elimination of Errors in Language

It appears that drill is helpful not only in forming correct habits, but also in eliminating incorrect habits. The value of formal drills for the latter purpose was investigated in an experiment by Thomas,[2] who studied in particular, multiple-response drills and dictation drills. The multiple-response drills contained series of sentences which were either correct or contained an error in grammar, punctuation, or spelling. The pupil's task was to encircle a letter that indicated his recognition either of the correctness of the sentence or of the type of error involved. The dictation drills consisted of sentences which were dictated by the teacher and were to be copied by the student. They gave practice in spelling, capitalization, and punctuation. The drills were designed to correct the thirty most frequent specific types of error

[2] Thomas, Jesse E., *The Elimination of Technical Errors in Written Composition Through Formal Drill.* Doctor's Thesis, University of Iowa. 1930.

grouped under four main divisions, namely: spelling, capitalization, punctuation, and grammar. The drills occupied eighteen minutes of class time four days a week for twelve weeks, and were used by Grade-IX classes from seven schools. The remaining part of the class time was devoted to the study of literature. Each of these experimental classes was paired against a control class which used the same procedure, except that the drills were informal and were supplied by the teacher. In most cases, they were taken from the textbook. On Friday of each week the pupils from each class were required to hand in compositions, which were corrected by the teacher. In the experimental classes they were corrected according to an error-guide supplied by the experimenters, and in the control classes they were corrected according to the teacher's custom before the beginning of the experiment. Before and after the experimental period, the pupils from each class were required to write three test themes and to take informal objective tests in dictation, English mechanics, and the Pressey Diagnostic Tests in English Composition. The gains in all the tests were much larger for the experimental classes than for the control classes. The amount of gain in reducing errors and in improving English mechanics was three times greater in the experimental than in the control classes. In errors in dictation the reduction was 25 percent greater in the experimental classes, and in the Pressey tests the reduction was over 50 percent greater. The differences in gain between the experimental and control classes were from three to over eight times the amount of their probable errors.

Grading Themes Versus Correcting Them

The grading of themes appears to be just as effective as, and possibly more so, than correcting them. The tradi-

tional method of teaching composition has been to have the teacher correct the mistakes made on all compositions handed in by the pupils, and then hand them back to be rewritten. This procedure has been the principal drudgery of the English teacher's work. An experiment by Fellows[3] indicated that this drudgery might be avoided by the substitution of theme-grading and appropriate language drills. In theme-grading the teacher did not mark the errors, but put a grade on the paper, which was returned to the pupil for his information; but it was not to be rewritten. In theme-correcting the papers were graded and the errors inked in red in the "good, old-fashioned way." The papers were returned to the pupils and were required to be rewritten. The results showed no advantage for the latter procedure. In fact, theme-grading was more effective than theme-correcting for reducing errors in capitalization, but theme-correcting was somewhat better for reducing errors in punctuation and in grammar. From this we may conclude with the author that the merit of theme-correcting is highly questionable.

Applying Corrective Drill at the Point of Error

Possibly the most sensible procedure in improving language habits is to find out what errors the individual makes and follow this by drills designed to correct them. The value of such a procedure was shown in similar experiments made by Warner and Guiler,[4] Guiler,[5] McGraw,[6]

[3] Fellows, John E., "Theme Reading in Written Composition," *School Review*, Vol. XXXVIII (1930), pp. 368–372.

[4] Warner, Paul C., and Guiler, Walter S., "Individual *vs.* Group Instruction," *Journal of Educational Psychology*, Vol. XXIV (1933), pp. 140–151.

[5] Guiler, W. S., "Improvement and Permanency of Learning Resulting from Remedial Instruction," *School Review*, Vol. XLI (1933), pp. 450–458.

[6] McGraw, H. Ward., "The Use of Test Data as a Basis for Drill in Grammar," *Journal of Educational Research*, Vol. X (1924), pp. 291–296.

Ransom,[7] and Rodgers.[8] We refer briefly to the experiments by Warner and Guiler and by Ransom. Warner and Guiler investigated the amount of improvement that might be expected for a limited period of intensive teaching and practice in grammatical usage. In order to overcome difficulties of pupils in the experimental classes, the following steps were taken: first, the preliminary test papers were carefully analyzed for individual errors; second, diagnostic charts were made for the particular principle of grammatical usage in which each pupil had encountered difficulty; third, the learning needs of each pupil were clearly indicated in his own work book; and fourth, the classroom work was organized on the basis of specific needs of the pupils. Besides the experimental group, two other groups, a control and a check group, were used. The control group followed the traditional procedure without any attention to individual needs. The check group took the tests at the beginning and end of the experiment, but in the meantime received no instruction in language. Each group consisted of fifty-eight pupils from Grade IX and forty-two pupils from Grade X. The percent of improvement made by the experimental group in Grade IX was 29.4, and by the control group, 19.6. The corresponding figures for Grade X were 36.4 and 22.8. The number of principles with which the pupils from Grade IX had difficulty was reduced 25.5 percent in the experimental group, and 16 percent in the control group. The corresponding figures for Grade X were 35.6 and 17.5. These results show a definite superiority of individual instruction over mass instruction.

[7] Ransom, Grace, "Remedial Methods in English Composition," *English Journal,* Vol. XXII (1933), pp. 749–754.

[8] Rodgers, Grace Sater, *A Critical Study of Grammatical Errors of Junior High School Pupils.* Master's Thesis, University of Southern California, 1930.

The procedure in the experiment by Ransom was similar to that used by Warner and Guiler. Two groups of thirty-one pupils each were used from Grade X. In the experimental class, sixteen types of errors were selected for special drill. These included 80 percent of the total number of errors made by the experimental pupils, and 75 percent of the errors made by the control pupils. The average of types of error per individual in the experimental group was found to be 5.83, a fact which made it easy to assign individual corrective exercises in a work book planned for the purpose. Each pupil in the experimental group kept a record of his errors in the diagnostic test, of his own assignments, and of the exercises as he copied them correctly. In the control group, the pupils wrote twelve original compositions and learned the rules governing the sixteen most common errors which were chosen for special drill in the experimental group. The errors in their compositions were numbered to correspond with the principles governing them, and with the aid of this information the pupils corrected their own errors. Each group spent the same amount of time on its work —about thirty-two class periods. The results showed that the experimental group reduced its errors by 66.6 percent and the control group by 35 percent. In a second experiment conducted in a similar manner, the experimental group reduced its errors by 60.1 percent and the control group by 33.6 percent. It should be noticed that in these experiments an analysis was first made of the errors peculiar to each individual, and then corrective practice was given according to the needs of each. The results warrant the conclusion that individual instruction according to need is an effective procedure in forming correct language habits and that teachers should give more attention to this procedure.

Improving Habits in Special Phases of Language by Intensive Drill

Pupils are frequently weak in a special phase of language, such as the use of connectives, personal pronouns, verb forms, or plurals. Any such specific weakness may be corrected by intensive drill. One experiment that illustrates the value of this procedure was made by Schwegler [9] in the use of connectives. She was interested in connectives because of the widespread opinion that their correct usage is dependent primarily upon intelligence. She selected from a commercial high school four classes of about twenty-five pupils each, two experimental and two control, which she equated for ability on the basis of the Terman Group Test of Mental Ability. In the experimental classes attention was concentrated for a period of three weeks on the use of five coördinate conjunctions, fifty-six subordinate conjunctions, eleven relative pronouns, and fifty-nine prepositions. The control classes received the ordinary instruction in English without any work on connectives. Before and after the experimental period, a composition test and a completion test based on omitted connectives were given to all the classes. The compositions were scored by means of the Nassau County Supplement to the Hillegas Scale. The results showed that in the completion test the experimental classes gained 32.88 points as compared with 12.62 points by the control classes, and in the composition test, the corresponding gains were 1.42 points and .06 points, respectively. The experimenter concluded that skill in the use of connectives was a product of training rather than of intelligence. The experiment should be taken as illustrating that the use of particular forms may be greatly

[9] Schwegler, Lydia M., "A Study in English Connectives," *English Journal*, Vol. XIV (1925), pp. 213–221.

improved by a comparatively short period of intensive drill.

The Most Common and Serious Errors

In view of the effectiveness of corrective practice applied at the point of error, it is important to know the types of errors most frequently made by pupils in both written and oral composition. It is equally important to know the seriousness of an error; for if an error is not serious, it is not worth while spending a great amount of time in correcting it. A number of studies have been made of the frequency of errors, but so far there are only a few on the seriousness of errors.

The model on which most investigations of errors in spoken English are based is the investigation made by Charters and Miller [10] in the schools of Kansas City, Missouri, and published in 1915. Their procedure was to have teachers make memoranda of errors which they heard from pupils during a certain period. Each error was written on a separate slip of paper. At the end of the period they were classified by grammatical groups and counted. Following the study by Charters and Miller, a number of similar investigations were made in other cities. Before 1934 at least thirty-three investigations were made of the errors in written and spoken English. Harap [11] made a careful study of these and obtained from them the following classified list of the most common grammatical errors:

I. Verbs

1. Disagreement of a verb with its subject in person: *don't* for *doesn't.*

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[10] Charters, W. W., and Miller, Edith, *A Course of Study Based Upon the Grammatical Errors of School Children of Kansas City, Missouri,* University of Missouri Bulletin, Vol. XVI, No. 2, 1915.

[11] Harap, Henry, "The Most Common Grammatical Errors," *English Journal,* Vol. XIX (1934), pp. 440–446.

2. Disagreement of a verb with its subject in number: *Hair are, was* for *were, is* for *are.*
3. Wrong number of verb with expletive *there: There remains three boys to see.*
4. Disagreement of a verb with a singular noun that has a plural ending: *Athletics are.*
5. When separated from a subject by a phrase: *Not one of our friends were there.*
6. Singular verb with a compound subject joined by *and: How is John and his brother?*
7. After a pronoun whose antecedent is overlooked: *She is one of those who is easily overlooked.*
8. After *neither: Neither of us deserve the prize.*
9. Wrong past tense: *seen* for *saw, come* for *came, begun* for *began, done* for *did, give* for *gave, run* for *ran, laid* for *lay, swum* for *swam, drunk* for *drank, would run* for *ran, use* for *used, sung* for *sang, says* for *said, dove* for *dived, was* for *were.*
10. Failure to use past perfect tense: *I found him almost recovered though he was quite ill.*
11. Failure to use present perfect tense: *See me after you see Mr. Smith.*
12. Change of tense in main clause.
13. Wrong past participle: *went* for *gone, did* for *done, saw* for *seen, froze* for *frozen, came* for *come, broke* for *broken, laid* for *lain, swam* for *swum, tore* for *torn.*
14. Use of double negative: *Could not hardly* for *could hardly; didn't have no, ain't have no, ain't got no, didn't do nothing; hadn't no* for *hadn't.*
15. Use of wrong verb: *lay* for *lie, leave* for *let, lend* for *borrow, sat* for *set, set* for *sit, learn* for *teach, can* for *may.*
16. Use of redundant *got: have got* for *have, have not got* for *have not.*

II. Pronouns

17. Subject not in the nominative case: *John and me are going to camp this summer.*
18. Predicate nominative not in the nominative case: *It is him; It is me.*
19. The use of wrong cases of pronouns after *than* and *as* and *as well as: He is taller than me; This misfortune falls more heavily upon you than I.*
20. Object of a preposition not in the objective case: *Mother sent for John and I.*
21. Object of a verb not in the objective case: *Mother sent John and I.*

22. *Whom* for *who; who* for *whom.*
23. Wrong formation of compound pronouns: *They hurt theirselves.*
24. Use of objective for possessive with gerund: *I'm tired of him complaining.*
25. Disagreement of pronoun with its antecedent: *Will everyone bring their paper?*
26. Confusion of *its* and *it's: Its hard to tell; The dog hurt it's paw.*
27. Use of *which* for *who* and vice versa: *He is the man which I meant; This is a dog who knows his tricks.*
28. Lack of clear reference of pronoun to antecedent: *Mary told her friend that was mistaken.*

III. Adjectives and Adverbs

29. Incorrect comparison of adjectives.
30. Use of adjective for adverb when modifying a verb: *He is most done; Everyone will be treated fair.*
31. Use of adjective for adverb when modifying an adjective: *awful* for *very; real* for *very.* (This error also involves many other specific cases including the misuse of *good, easy, careless, fine, safe, different, neat, bad.*)
32. Use of adverb for adjective after a copulative verb: *He feels badly.*
33. *Only* misplaced in a sentence: *He only helped the boys.*
34. Use of *those* and *these* for *that* and *this: I like those kind of grapes.*
35. Use of expression *that there* and *this here: That there man is my neighbor.*
36. Use of *them* for *these* and *those: Them things are ours.*

IV. Prepositions and Conjunctions

37. Use of superfluous preposition: *in back of* for *back of* or *behind, off of* for *off, start in* for *start, add up* for *add, end up* for *end; where are you at, return back.*
38. Use of wrong preposition: *off me* for *from me, by my aunt* for *to my aunt, to home* for *at home, different to* for *different from, in* for *into, between* for *among.*
39. Use of wrong conjunction: *like* for *as* or *as if.*
40. *Where* and *how* wrongly used as a conjunction: *Did you read where the boy was saved from drowning in the creek? Did you read how a man was killed?*

V. Nouns

41. Wrong use or form of number in nouns: nouns ending in *y* preceded by a consonant; nouns ending in *o* preceded by a

consonant; nouns ending in *is, basis;* plural of proper nouns; nouns which change their form in forming the plural, *phenomenon;* nouns which have no plural, *athletics;* nouns which have no singular, *scissors;* compound nouns, *brother-in-law.*

42. Wrong form of possessive case in nouns: after plural nouns ending in *s, teachers' dining room;* compound nouns, *court-martial.*

VI. Sentence Structure

43. Omission of subject: *Received your letter.*
44. Omission of predicate.
45. Dangling participle: *The boy gazed at his father, trembling with anger.*
46. Misplaced modifier: *She claimed she had paid her admission several times.*
47. Wrong handling of parallel structure: *He taught piano, violin, and vocal.* (should be *voice.*)
48. Double subject: *John, he went.*

VII. Punctuation

49. No period at the end of sentence.
50. No period after abbreviations.
51. No question mark at the end of a sentence.
52. Failure to set off a nonrestrictive clause by a comma.
53. Failure to set off a series by commas.
54. Failure to set off a parenthetical element by commas.
55. Failure to set off an appositive by commas.
56. Failure to set off a quotation by commas.
57. Failure to use quotation marks.
58. Failure to use a semicolon when there is no conjunction between clauses of a compound sentence.
59. Failure to use a semicolon to set off a series.
60. Failure to use parentheses.
61. Failure to use a colon.
62. Failure to use an exclamation point.
63. Apostrophe not properly used to show contraction.

VIII. Capitalization

64. Failure to capitalize proper nouns.
65. Failure to capitalize title of a book, articles, newspapers, or chapter headings.
66. Failure to capitalize the first word of a quotation.
67. Wrong use of capitals for the names of school subjects other than languages.

68. Wrong use of capital for title of a person when it is used as a common noun.

Technical Errors in Letter-Writing

Since letters constitute the major portion of the written composition for the majority of students after graduation from secondary school, it is worth while to refer to some of the studies of the technical errors in this form of composition, for example, those by Ashbaugh,[12] Bobbitt,[13] Johnson,[14] and Pressey.[15] Mrs. Bobbitt analyzed the technical errors occurring in letters of adults. The types of errors that she found are particularly interesting in view of the fact that our high-school graduates are most likely to err in the same way. Her material consisted of a random sampling of 362 letters appearing in the Chicago Tribune in the column, "Voice of the People." She found a total of 7,110 errors, or 20 errors per letter. The errors were distributed as shown in Table 1.

The errors found by Bobbitt in the letters of adults may be compared with those found by Johnson, Ashbaugh, and Pressey in the letters and compositions of students, for the purpose of showing in what respects adults are better or worse than students. Bobbitt and Johnson agreed in finding that errors in punctuation and expression constituted the bulk of the total errors in letters, but in Bobbitt's letters, the errors in spelling and grammar had a much lower rank than they did in John-

[12] Ashbaugh, E. J., "Non-School English of High-School Students," *Journal of Educational Research,* Vol. XV (1927), pp. 307–313.

[13] Bobbitt, Sarah A., *Shortcomings in the Written English of Adults: Investigations by Franklin Bobbitt and Others.* Supplementary Educational Monographs, No. 31, Chicago: Department of Education, University of Chicago, 1926, pp. 110–118.

[14] Johnson, Roy Ivan, "The Persistency of Error in English Composition," *School Review,* Vol. XXV (1917), pp. 307–313.

[15] Pressey, S. L., "A Statistical Study of Usage and of Children's Errors in Capitalization," *English Journal,* Vol. XIII (1924), pp. 727–732; "A Statistical Study of Children's Errors in Sentence Structure," *English Journal,* Vol. XIV (1925), pp. 529–535.

TABLE 1

FREQUENCY OF CLASSES OF ERROR IN THE LETTERS OF ADULTS
(From Bobbitt, 1926)

Class of Error	Frequency
Punctuation	2,796
Expression	2,287
Capitalization	1,183
Abbreviations	192
Spelling	191
Grammar	157
Improper margins	147
Errors in writing numbers	81
Errors in word-compounding	76
Total	7,110

son's. This indicated that high-school students improved in these directions after graduation. However, the errors in capitalization were more frequent in Bobbitt's letters than in Johnson's. When it came to particular errors in capitalization, Pressey's study showed that these occurred principally at the beginning of a sentence, at the beginning of a quotation, and in headings; but in Bobbitt's study, these errors were few, the most frequent type being the superfluous use of capitals. As to sentence structure, Pressey's study showed that stringy sentences and fragmentary expressions constituted about half of the errors; but according to Bobbitt, these errors amounted only to about eight percent of the total in this group, the principal error of adults being inconsistent logic within the sentence. As to punctuation, Bobbitt's and Ashbaugh's studies agreed that the most frequent error was in the use of the comma in connection with parenthetical modifiers. In both studies, the incorrect punctuation of abbreviations, the incorrect use of the commas in series, and the incorrect use of the apostrophe had high frequencies. Although these comparisons are

somewhat unreliable because of the differences in the classifications used by the authors and the mixed character of the populations used in the studies, yet they indicate that adults, in comparison with high-school pupils, make fewer errors in spelling, grammar, the use of capitals in beginning a sentence or quotation, and in using stringy or fragmentary sentences. Adults are probably not very much better than high-school students in punctuating parenthetical modifiers, abbreviations, contractions, and possessives.

Theoretically, it would seem that one school generation, or eight years of intensive corrective drill, would be ample for eliminating most of these errors from the language of the population that receives the training, but as a matter of fact, little perceptible progress is likely to be made within that time. In fact, it would not surprise us to find, if Charters repeated his survey in 1940, that he would discover results closely corresponding to those obtained in 1915. Two reasons for this are, namely: that the teachers are not likely to give the requisite instruction, and that language habits, as other *mores,* are slow to change. However, this resistance is no good reason for neglecting to make a drive to eradicate errors. This drive, if long continued, should, according to the laws of learning, eventually produce the correct habits. But group instruction alone would not accomplish this result, for many errors are not common to the group but peculiar to the individual. The remedy for this type of error is individual instruction. The facts upon which this should be concentrated cannot be determined by following frequency tables of common errors, but should be ascertained by careful individual diagnosis. In fact, a first-hand diagnosis should also be made for the purposes of effective group instruction. The lists of common

errors given above are useful as guides for directing instruction and serve their purpose by giving the teacher an idea of what to expect in her diagnostic work.

The Seriousness of Errors

The frequency of an error is not always an index of its seriousness. To say "was" for "were" frequently is bad English but hardly as bad as to say "Me, no English" as a complete thought. An error may be serious because of the number of times it occurs in relation to the possible number of its occurrences; because of its frequency, its interference with the expression of thought, or its persistence. Since it is not possible to eliminate all language errors, it is advisable to work on those that are most important. But to determine their relative importance is a difficult problem. Johnson [16] evaluated the importance of errors by taking the sum of their ranks in both frequency and persistence. For example, he found that mistakes in capitalization in high-school compositions ranked second in both frequency and persistence, while mistakes in spelling ranked first in frequency but eleventh in persistence. The sum of the ranks for capitalization would thus be four, and for spelling twelve. He suggested, therefore, that mistakes in capitalization should receive much more emphasis than mistakes in spelling. According to Stormzand [17] the importance of an error is determined by its error quotient, which is obtained by dividing its frequency by the number of its possible occurrences. According to this index, *omission of comma setting off dependent clauses out of their natural order* ranks first, *omission of hyphen in compound words* ranks second, and *use of incomplete sentences*

[16] *Loc. cit.*

[17] Stormzand, Martin J., and O'Shea, M. V., *How Much English Grammar?* Baltimore: Warwick & York, Inc., 1924.

ranks thirty-first. The inference is that corrective teaching should be emphasized according to the rank of the error.

Price [18] sought to determine the seriousness of errors by finding the consensus of opinion of twenty-five teachers on the order of seriousness of twenty-five violations of good sentence structure. The errors ranking from one to ten by this method are as follows:

1. Fragments as complete sentences.
2. Incomplete constructions or undeveloped thought.
3. Omission of capital letters.
4. Omission of terminal punctuation.
5. Unrelated ideas in one sentence.
6. General incoherence.
7. Stringy sentences.
8. Shift in person.
9. Shift in tense.
10. Divided references of pronouns.

One criticism that may be made of these methods of determining the order of seriousness of language errors is that none of them is determined by a fundamental principle inherently related to language. Johnson's criterion is a compromise between frequency and persistence, while Stormzand's is the ratio of actual frequency to possible frequency. Either of these is about as unrelated to the function of language as anything imaginable. The consensus of teachers' judgments should have some value, but it is determined by a group of unknown factors. All these criteria lead to absurdities in language instruction. For example, Johnson's criterion would give far more emphasis to mistakes in capitalization than to sentences unclear in meaning. Stormzand's criterion would put much more emphasis on inserting hyphens be-

[18] Price, Edwin, *A Study in the Evolution, Frequency of Occurrence, and Method in the Elimination of Sentence Errors Among Junior High School Students.* Master's Thesis, Stanford University, 1923.

tween compound words than on the correction of incomplete sentences. And the consensus of teachers' judgments, according to Price, is that capitalization should receive more attention than the elimination of unrelated ideas from a sentence. Such misapplications of emphasis in instruction follow from the weakness of the criterion used for evaluating the seriousness of an error. The remedy is to find a more adequate criterion. What this should be is matter for future research, but it seems that since the function of language is communication, the seriousness of an error might be determined by the extent to which it interferes with that function. According to this standard, the use of fragmentary expressions as complete sentences, insertion of unrelated ideas into a sentence, use of stringy sentences, omission of necessary words, and divided reference in a pronoun would be errors of the highest rank in seriousness, while the use of "was" for "were," mistakes in spelling, or omission of a hyphen in a compound word would not be serious.

The Judgment of Experts on the Acceptability of Various Expressions in English

In connection with the study of language it is interesting to refer to Leonard's [19] study of the opinions of experts on the acceptability of various expressions that are ordinarily condemned in English textbooks and classes. Two hundred and thirty expressions were classified by more than two hundred judges as "formally correct in literary English," "standard, cultivated, colloquial English," or "illiterate, popular English." Among the judges was a group of twenty-six eminent linguists whose opinions are worthy of consideration as representing the

[19] Leonard, S. A., *Current English Usage*, English Monographs, No. 1, Chicago: National Council of Teachers of English, 1932.

judgment of specialists. These experts were asked to judge according to what they observed in the usage of those about them, not necessarily according to what they themselves used or believed should be used. The following are samples of disputed expressions approved by some experts:

This room is *awfully* cold.
It is *me*.
Who are you looking for?
Invite *whoever* you like to the party.
Drive *slow* down that hill.
I have *got* my own opinion on that.
There *was* a bed, a dresser, and two chairs in the room.
I wish I *was* wonderful.
I've no doubt *but what* he will come.
Can I be excused from this class?
Haven't you *got through* yet?
Everyone was here, but *they* all went home early.
My *folks* sent me a check.
He came *around* four o'clock.
If it had been *us*, we would admit it.
They went *way* around by the orchard road.
The banker *loaned* me $200 at 6%.

The acceptability of these expressions by expert linguists should give many writers of textbooks and also many teachers easier consciences about the awfulness of grammatical errors, but we should not take them to be suitable under all conditions. At best, they may be fitting for informal conversation, but to accept them in written composition opens the door to carelessness and increases the difficulty of reaching one of the major objectives of teaching composition, namely, the development of habits of correct expression. What is appropriate in English depends upon the situation in which the language functions. The standards of correctness are, and no doubt should be, different for an English classic, a textbook, a typewritten business letter, an informal

letter to a friend, and an informal conversation with friends. If the foregoing expressions and their like are understood in this light, they serve a useful purpose.

Methods of Finding Language Errors

If language errors are to be eliminated, we must first have some economical way of finding them. In the published studies of errors in spoken English, the prevailing method of finding the errors has been to have teachers, equipped with pencil and pad, keep an open ear for any error they might hear from their pupils, and then make a note of it. After thousands of errors were collected in this manner, they were grouped into classes designed to fit them, and then counted. One investigator, Randolph,[20] used a more exact method of recording such errors by having stenographers copy every word that the pupils spoke. In contrast with the results of other studies he found the most frequent errors to be in sentence structure. This suggests that teachers are probably inattentive to certain types of errors overheard in conversation, and that the informal records made by most teachers fail to give a true picture of the common errors. But whatever merits each method has, either is too laborious and time-consuming to be used by English teachers in their daily work. Attempts have been made to devise short cuts to a picture of students' error vocabulary by the construction and application of so-called diagnostic language-error tests. An extensive study of the validity of such tests was made by Willing, who correlated the results obtained from the administration of twenty-one formal language tests with the number and kind of errors made in 1,200 words of composition written by each of

[20] Randolph, Edgar D., "Conventional Aversions versus Fundamental Errors in Spoken English," *Pedagogical Seminary*, Vol. XXIV (1917), pp. 318–336.

107 pupils from Grades VIII and IX. His principal conclusions were that comprehensive readings of error-recognition tests were reasonably good instruments for predicting the average number of formal errors that a group of pupils would make in 1,200 words of diversified written compositions on a familiar subject, but that they were not suitable for predicting the specific kinds of errors made by individual pupils. The latter can be predicted only from an accurate and detailed analysis of an extensive amount of written composition. There is a great need of tests that will make such individual prediction possible.

Summary

When practice is combined with knowledge of results and of the goal to be obtained, it is a very important factor in the learning of language habits. Its function is not to develop the ability to think nor to give the pupils something to say, but rather to develop habits of correct expression. Experimental investigations have demonstrated the value of a number of types of drill. Among them are the following: (1) formal drills on correct usage; (2) formal drills on the elimination of errors; (3) theme-grading rather than detailed theme-correcting; (4) intensive drills on extensive phases of language habits that need development; and (5) corrective drills applied at the point of error.

Because of the effectiveness of corrective drill applied at the point of error, it is very important to know the most frequent errors made in language. Ideas of what to expect in language errors may be obtained from studies of tables showing frequencies of errors. Such a table should not be a substitute for first-hand diagnoses of either a group or an individual. The necessity of the latter is due

to the fact that many errors are peculiar to both the individual and the group.

Since a comparatively small variety of errors makes up the majority of the total errors in the use of language, it seems that an intensive and consistent campaign for their eradication would make a big improvement, but this has yet to be demonstrated.

No satisfactory method has so far been found for determining the order of seriousness of language errors. Johnson's combination of frequency and persistence, and Stormzand's error quotient lead to absurdities in instruction. The consensus of teachers' judgments is a safer but nevertheless faulty guide. It seems that the seriousness of an error should be determined in part by the extent of its interference with communication. The consensus of the judgments of linguists is also a useful guide. It should give many teachers easier consciences.

No quick and easy method has yet been found for diagnosing pupils' language errors. Comprehensive error-recognition and proof-reading tests are reasonably good instruments for determining corrective group instruction, but they are unsatisfactory for finding the needs of individual instruction. The latter requires the examination of a number of pages of natural writing.

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CHAPTER 4

English Composition: Individual Differences

The development of language is closely related to the development of the individual. It begins at birth and changes with the individual throughout his life. Possibly no other activity gives such a complete picture of mental development as does language. Its growth is influenced by practically all the factors that influence the growth and development of the individual. Among these are both hereditary and environmental factors, of which the latter are very important. The principle hereditary factors are maturation, sex, and race, while the more important environmental factors are the home, the local community, bilingualism, and the amount of formal education. It is the purpose of this chapter to show the relation of language ability to these factors.

Differences in Relation to Maturation

The growth of language is shown in a number of ways, such as by the increase in vocabulary, the length of the sentence, changes in sentence structure, the use of subordinate clauses, and the character of the words used. The use of words begins at about twelve months, when a baby can say one or two words. From that point the vocabulary increases very rapidly. According to an investigation by Smith[1] the average annual increase in the

[1] Smith, Madora E., "An Investigation of the Extent of Vocabulary in Young Children," *University of Iowa Studies in Child Welfare*, Vol. III (1926), No. 5.

number of words used from two years to six years is 472.5. After that time, the increase is undoubtedly more rapid on account of the great amount of time spent in formal education between the years of six and eighteen. The average size of a high-school graduate's vocabulary is not accurately known, but has been variously estimated at between 12,000 and 58,000 words. It probably is nearer the higher than the lower figure. The number of words known by an individual is probably the best index of his language development, but this is also shown in other forms of language. The length of the sentence changes from one word at twelve months to about nineteen words for a high-school senior.[2] The average increase in length of sentence during this period is about one word each year. In sentence structure there are various changes. The percentage of simple sentences increases during the first six years, but after that it decreases, the exact age when the maximum percentage of simple sentences is used not being known.[3] Complex, compound, and complex-compound sentences increase from Grades III to adulthood. Children begin to use them before Grade III, but at what age is not accurately known. According to Nixon[4] the percentage of simple sentences decreases from 56 percent in Grade I to 49 percent in Grade III. According to Hoppes[5] the percentage of simple sentences decreases from 55.4 in Grade III to 43.2 in Grade VI. On the other hand, the percentage of complex sentences increases from 28.4 in Grade III

[2] Stormzand, Martin J., and O'Shea, M. V., *How Much English Grammar?* Baltimore: Warwick & York, Inc., 1924.

[3] Frogner, Ellen, "Problem of Sentence Structure in Pupil's Themes," *English Journal,* Vol. XXII (1933), pp. 742–749. Also La Brant, Lou L., *Study of Certain Language Developments of Children in Grades Four to Twelve Inclusive.* Doctor's Thesis, Northwestern University, 1932.

[4] Nixon, Anna M., *Sentence Structure in the Oral Language of Certain Primary Grade Pupils.* Master's Thesis, University of Iowa, 1932.

[5] Hoppes, William C., "Considerations in the Development of Children's Language," *Elementary English Review,* Vol. XI (1934), pp. 66–70.

to 41.4 in Grade VI. According to Stormzand and O'Shea the ratio of dependent clauses per one hundred sentences increases from 24 in Grade IV to 83 in Grade XII.

Among the factors that favor language development are high intelligence and good economic status. On the other hand, it is unfavorably influenced by low economic status, low intelligence, excessive motor activity, and bilingualism. The significance of these changes in the development of language in relation to age is that the changes appear to come at the proper degree of development regardless of the instruction. Their pedagogical importance is that the type of language taught should be closely adjusted to the pupil's degree of development.

Differences in Relation to Sex

Most language tests confirm popular opinion in regard to sex differences in language; that is, they show that women are superior in linguistic ability. This is evidenced during the first year of life by the fact that baby girls start to talk earlier than baby boys. It is also apparent during the years in which the two sexes are in junior high school. According to LaBrant,[6] the average length of composition for girls at that time is 148.3 words per theme, and for boys it is 124.7. In senior high school the averages are 179.1 and 148.6, respectively. These results, however, have little pedagogical significance. The differences are too small to justify segregation of the sexes in language instruction.

Differences in Relation to Race

Some tests show rather large differences between the white and colored races in language ability. For ex-

[6] *Op. cit.* (footnote 3).

ample, in the Army Alpha Test, the synonym-antonym test shows an average score of 7.94 for the unselected white draft, and 0.88 for the unselected colored draft. The disarranged-sentence test shows an average score of 7.16 for the unselected white draft and 2.06 for the unselected colored draft. However, when individuals are selected from the two races who match each other in mental ability, then the differences turn in favor of the colored race. For example, in the free association test used in the Yerkes Point Scale,[7] the average score for the colored race is 166.6 percent of the white score. Other tests show smaller differences. Such results raise the question of whether the differences found between the two races in the unselected draft represent differences in native ability or in culture.

Differences in Relation to the Home and the Community

While it is difficult to measure the influence of the home as an isolated factor in the child's linguistic development, there can be no doubt of its importance. The child learns the language of his parents—not only the dialect, but also the form of expression, the words, and the pronunciation. The influence of the home is seldom isolated from that of the community. Usually the language in the home is an expression of the language of the community. In a heterogenous community there are numerous exceptions to this rule, but in most cases, the language of the home is an expression of the social class in which the family moves. The importance of the home and the community is due to the fact that it is in them that the child's first language habits are formed and are

[7] Yerkes, R. M., Editor, *Memoirs of the National Academy of Sciences*, Vol. XV (1921).

principally used. It is possible that the school may change this system, but if it does, it must counteract the customs and usually the disapproval of both home and community. Furthermore, it must do it in a fraction of the time which the community would require. Under the circumstances, the complete corrections of wrongly formed habits are the exceptions rather than the rule.

Differences in Relation to Grade

Since language develops in relation to age and maturation, as described in the foregoing paragraphs, it is evident that it changes in relation to the child's grade. This is shown in all standardized linguistic tests. For example, the Hillegas Scale shows that the quality of composition changes in score from 3.0 in Grade III to 6.7 in Grade XII. The Pressey "Diagnostic Test in English Composition" shows that the score in capitalization changes from 18 in Grade VII to 23 in Grade XII, while that for punctuation changes from 10 in Grade VII to 21 in Grade XII. According to Abbott-Trabue, "Exercises in Judging Poetry," the score changes from 4.0 in Grade VII to 6.0 in Grade XII. According to the Inglis vocabulary test the score changes from 45 in Grade IX to 87 in Grade XII. All of these scores are indices of degrees of language development and may be duplicated in many other tests.

Individual Differences Within Grades

More significant than average differences between groups, such as age groups, grade groups, sex groups, and race groups, are the individual differences within a group. Such differences are shown in the distribution of the scores of individuals within the same grade, but they may be shown equally well in any other group. Individ-

ual differences within a grade are shown in tests given by the writer to high-school students. One of these was the Nelson High School English Test administered to pupils in Grades IX, X, XI, and XII; and the other was the Hudelson composition test given to high-school seniors. The distribution for the Hudelson scores is shown in Table 2 and that for the Nelson High School English Test in Table 3.

TABLE 2

DISTRIBUTION OF HUDELSON COMPOSITIONS
(243 high-school seniors)

Grade	Norm	Number Making Each Grade
3	2.7	7
4	3.0	16
5	3.6	47
6	4.2	72
7	4.7	53
8	5.3	23
9	5.5	10
10	5.9	11
11	6.3	4
12	6.7	—
Average	4.25	—

Similiar distributions may be obtained from any other linguistic test. The most significant fact of the foregoing tables is that the differences between groups are small and even negligible, and that group instruction can at best be adjusted only to a small percentage of the group. If instruction in language is to meet the needs of the individual, the emphasis must be placed upon individual instruction.

Plans for Meeting Individual Needs

The usual plans for meeting individual differences, such as homogeneous grouping, group teaching accom-

TABLE 3

DISTRIBUTION OF SCORES FOR NELSON HIGH SCHOOL ENGLISH TEST

Score	Frequencies			
	Grade 9	Grade 10	Grade 11	Grade 12
215			1	
210				1
205		1		2
200	1	5	3	3
195	4	1		3
190	2	4	6	5
185	1	8	13	8
180	3	7	2	5
175	5	12	8	9
170	6	15	12	11
165	8	12	10	17
160	6	11	6	9
155	11	14	16	13
150	20	9	15	12
145	10	6	7	6
140	12	9	10	8
135	11	11	8	3
130	20	11	9	10
125	6	6	5	2
120	16	5	5	2
115	16	6	8	1
110	6	3	1	
105	14	3	5	1
100	8		6	
95	14	1		1
90	3	2	1	1
85	[illegible]			
80	3	1		
75				
70	1			
65	2	1		
60				
55				
50				
Number	212	164	157	133
Median	133.5	157.85	154.2	162.5

panied by individualized drill, supervised teaching, the Dalton Plan, the Winnetka Plan, and individual diagnosis, have been adapted to the teaching of composition.

Homogeneous grouping. Some investigations which have been made with this form of instruction show no advantage, while others show a considerable amount. In an experiment made by Cook[8] in the Topeka High School, it was found that pupils in homogeneous groups made no more progress than pupils of the same ability in mixed groups. However, in this case the instruction was the same in all the classes. On the other hand, an experiment made by Lau[9] in the Rock Island High School showed that pupils in homogeneous groups gained from one to 40 percent more than pupils of the same ability in mixed groups. In this case the instruction was differentiated. The low group received three times as much drill as the middle, and the middle group received twice as much drill as the high group. In another experiment by Billett[10] it was found that the advantages of ability grouping were principally in favor of the slow and average groups and that they were often to the disadvantage of the fast group. This may be illustrated in the results obtained from the Hudelson Composition Test. The slow homogeneous group gained 1.67 as against 1.13 by the slow ones in the mixed group. The average homogeneous group gained 1.88 as against 1.37 by the corresponding individuals in the mixed group. The fast homogeneous group gained 1.27 as against 1.38 by the corre-

[8] Cook, R. R., "A Study of the Results of Homogeneous Groupings of Abilities in High-School Classes," *Twenty-Third Yearbook of the National Society for the Study of Education*, Part I (1924), pp. 302–312.

[9] Lau, Arnold, "Adaptation to Group Needs on Ability Bases in Ninth Grade English," *Sixth Yearbook of the National Association of Secondary School Principles* (1922), pp. 63–85.

[10] Billett, R. O., "A Controlled Experiment to Determine the Advantages of Homogeneous Grouping," *Educational Research Bulletin* (Ohio State University), Vol. VII (1928), pp. 133–140.

sponding ones in the mixed group. Billett concluded from his investigation that the advantage in favor of homogeneous grouping outweighed the disadvantage. However, homogeneous grouping is at best only a partial adjustment, for wide individual differences remain because individuals having equal scores in an objective test learn a subject at varying rates.

Group teaching accompanied by individualized drill. The method of group instruction accompanied by individualized drill has been discussed under the topic, "Corrective Practice Applied at the Point of Error" (page 20). This has been found to be a superior method of instruction.

Supervised study plan. Many needs of individuals may be met by the use of supervised study. A successful adaptation of this practice has been developed in the University of Chicago High School. Mr. Hanes[11] describes it as follows:

"In the beginning, each pupil is tested in order to determine his present knowledge and power, and auxiliary evidence of current practice is gathered from the papers which he writes for subjects other than English. In this way the individual need of each pupil is determined and recorded.

"The pupil, having been apprised of his characteristic errors and convinced of the necessity of correcting them, is introduced in turn to the principles involved. The presentation of each principle is followed by practice exercises until he shows under testing his understanding of the principle and his mastery of the correct practice. Further observance of the correct usage then becomes his responsibility and personal obligation in all compo-

[11] Hanes, Ernest, "Supervised Study in English," *School Review*, Vol. XXXII (1924), pp. 356–363.

sition work, not only English but in all subjects involving expressional activities.

"The principles involved in the correction of such errors as are common to all of the members of a class or to any considerable number of the pupils are presented by the instructor in general lessons to the entire class or to the group needing the instruction. The presentations of the principles, together with the illustrations of their use, may be strengthened by means of similar material from the textbook. During the use of such textbook material and during the subsequent period of practice the pupils engage in study under the supervision of the instructor. The teacher moves quietly about the room while the pupils are studying or practicing their exercises and gives supplementary explanations, repeats the information already given, where necessary, checks the correctness of the exercises completed, administers tests to the pupils who are ready for them—in short, offers the stimulation or guidance that each pupil requires. It can be readily surmised that in such a procedure some pupils will progress more than others. Since the work is highly individualized and there is a record of each individual need, any pupil can attack a new problem as soon as he has satisfactorily mastered the first. If it is desired to make a group presentation from time to time, the pupils who finish a problem ahead of their classmates are permitted to read from the literature content of the course. Books are at all times available in the classroom for this purpose.

"The classroom thus becomes the workroom of from twenty to thirty pupils, each at work on a project in the successful completion of which he may need from time to time the instructor's assistance, either in straightening out his thinking or in stimulating his will to progress.

The functions of the instructor are stimulation, sympathetic guidance and explanation, and constant observation of individual progress. There is recitation, no group testing of results. The unit of instruction is the individual; the unit of content, the principle he must learn to observe. Progress is determined through testing the individual and observing his subsequent unsupervised work."

In this procedure the instruction meets the individual in the following ways: it allows him to spend his time on what he needs to do; he progresses at his own rate; he quits a task as soon as he has mastered it; within certain limits, he may choose the materials and methods of learning each task. The tasks to be done may not meet the individual's interests or likes, for these are determined by the school, by convention, and by society; but since an individual lives in a society, and can work with others only on the basis of a common content, it is not a serious fault of education if an individual is required to study what he dislikes or finds uninteresting.

The Dalton Plan. The principal features of the Dalton plan [12] are that the assignments are made by units or jobs and are worked out coöperatively in a laboratory. In English, for example, eight to ten units of work are assigned, or one for each month of the school year. These units are determined by logical divisions and are subdivided into smaller logical units so that the pupil has one for each week and one portion of this for each day. Each piece of work, for example, a composition, is due when it is finished. If it is not satisfactory, the student must do it over. No unit is finished until it is done satisfactorily. When it is finished the student receives

[12] Parkhurst, Helen, "The Dalton Laboratory Plan," *Twenty-Fourth Yearbook of the National Society for the Study of Education*, Part II (1925), pp. 83–95.

credit on a record provided for the purpose, and then proceeds to the next task.

The Winnetka Plan. The Winnetka plan[13] centers upon individual work for tool subjects and coöperative work for creative subjects. Language, insofar as it relates to learning correct speaking and writing, is a tool subject, but so far as it relates to drama, art, and forensics, it is a creative subject. The essential features of the individual instruction are:

1. Determining an individual achievement and specific needs by standardized tests.
2. Setting up definite goals for each grade.
3. Using practice exercises devised specifically for reaching the goal.
4. Measuring the attainment of a goal by an objective test.
5. Allowing the pupil as much time as he needs for attaining the goal.
6. Motivating the pupil by a record of his progress.
7. Omitting recitations, the usual school marks, failures, and skipping.
8. Self-correcting errors by a comparison with a correct model.

An idea of the nature of the goals may be formed from those set up for the language work of Grade V:[14]

1. Simple possessives.
2. Tricky possessives.
3. Plural possessives; as, *boys'*.
4. Plural possessives; as, *children's*.
5. Comma in series.
6. Comma in address.
7. Comma: *yes, no, oh*.
8. Simple quotation.
9. Exclamations.
10. Capital for deity.
11. Paragraphs.

Let us suppose that a child has completed the first four goals. His next step is to read the developmental

[13] Washburne, Carlton W., "Burk's Individual System as Developed at Winnetka," *Twenty-Fourth Yearbook of the National Society for the Study of Education*, Part II (1925), pp. 77–83.

[14] Douglas, Lucile, "Teaching English on the Dalton Plan," *English Journal*, Vol. XIII (1924), pp. 335–340.

material on the "comma in series." After learning the rules for the form of punctuation, he begins practicing on materials which require a number of commas in series. After reaching a high degree of proficiency he takes a practice test in which he is required to copy correctly a paragraph from which all capitals and punctuation marks have been removed. If his corrected paragraph proves to be the same as the model in the book, he proceeds to his next goal. If it is not, he resumes practice until he can pass the test without making any errors.

Individual instruction is by no means limited to the three plans here discussed, although each of these shows that there are possibilities of organized plans for individual instruction. Often a combination of some of the features in each plan is more appropriate than the exclusive adoption of one of them.

Case-study method. A small percent of high-school students have such serious disabilities in language that they should be made subjects of individual diagnosis. Such cases should be treated as clinical cases by the case-study method.

The diagnosis of disability in language should include both informal and formal tests. Its purpose is to reveal the specific needs and weaknesses of the individual. The informal test should include a record of the errors that the individual makes in speech and in writing. If this is extended enough, it will reveal the most important facts. The formal diagnosis should be made with such tests as those of vocabulary, spelling, sentence structure, capitalization, word usage, punctuation, paragraph organization, and handwriting. At the high-school level there may be employed the Cross English Test, Briggs English-Form Test, Nelson High-School English Test, and Leonard Diagnostic Test in Capitalization and Punctu-

ation. Possibly an elementary language test such as the Iowa Elementary-Language Test will be more useful than one designed specifically for high school.

After the diagnosis is completed, the next step is to find remedies. These must be of such a character as to correct the defects found. Wherever possible, they should take the form of individual teaching, but if this is not practical, group teaching may be used in case the pupils are classified according to the deficiencies that they have in common. Individual teaching does not require the use of new methods so much as the individual adaptation of the methods that are ordinarily found effective in teaching language. Some conditions of individual teaching are: adaptation to needs, systematic practice, strong motivation, gradual increase in the difficulty of the work given, and gradual development of individual independence.

Summary

Ability in language is closely related to the individual's degree of development. It is dependent upon the growth of vocabulary, development of sentence structure, increase in length of sentences, and selection of words used. The individual begins to speak at about the end of the first year. After the second year his vocabulary increases at the rate of 475 or more words a year throughout the period of growth and of formal education. The high-school graduate's vocabulary is estimated to contain from 12,000 to 58,000 words, but it has never been accurately measured. The length of sentence is one word at the end of the first year and increases at the rate of about one word a year until the end of high school. The form of sentence used changes during the period of formal education. The use of simple sentences decreases from the

first to the twelfth grade and the percentage of complex sentences increases. The principal change in the character of the vocabulary is the increase in the use of abstract words.

Sex differences in language are comparatively small. Most tests show them to be in favor of the female sex.

Ability in language has a high positive correlation with intelligence.

There are marked racial differences in language ability, particularly between the white and the colored races, but it is uncertain whether this is due to differences in native ability or in culture. Individual differences within a group are much greater and far more significant than differences between the averages of groups. This is clearly shown in the distribution of scores in language tests given to pupils of the same class. This fact signifies that individual teaching should receive the major emphasis in language instruction.

There is a gradual increase in language ability with the advancement of the individual through the grades. This is shown in all standardized tests. More significant are the individual differences within one grade.

A number of devices have been designed for meeting the individual needs in language-teaching. Among these are homogeneous grouping, group teaching accompanied by individual drills, supervised teaching, the Dalton Plan, the Winnetka plan, and individual diagnosis. The advantages and disadvantages of any of these plans as applied to composition are not different from the plan in general.

Supplementary Reading

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book of the National Society for the Study of Education, Part I (1924), pp. 275–289.

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CHAPTER 5

English Composition: Motivation and Materials

The quality of a composition depends in part on the strength of the motive which the writer has in writing. Pupils often dislike the study of composition because they are not interested in the topics which are assigned to them; because they have no opportunity to express themselves to an interested audience; because they do not know whether or not they are making progress; because there is no one to help them overcome their difficulties; because they "get by" just as well with illiterate expressions as with good ones; because all too often the teacher's only reaction is a number of red marks scattered over the paper, which make them error-conscious rather than enthusiastic about writing more compositions; or because they cannot write compositions in connection with any interesting activities. All of these factors inhibit expression. Many believe that better compositions will result if these inhibitions are removed and pupils are given compelling motives for expression. A number of studies have been made which bring to light the value of various types of motivation, such as appeals to mastery motives, social motives, interesting subject matter, and socially useful activities.

Appeal to Mastery Motives

Mastery motives may be applied to the teaching of English composition by keeping a record of progress, obtained from measurement of the products of writing by

means of standardized scales. That the knowledge of such a record is a good incentive for improvement is indicated in a study made by Symonds and Chase.[1] In their experiment pupils from Grade VI practiced language exercises under three conditions, namely: (1) no motivation, (2) test motivation, and (3) intrinsic motivation. Under (1) the pupils did exercises according to directions, but were not told why they did them nor how well they did them. Under (2) they were told why, were given their scores, and were required to keep charts of progress. Under (3) they were motivated by talks on the values of good English. The practice consisted of doing exercises similar to those in the Charter's Diagnostic Language Tests. Improvement was measured by giving these tests before and after the practice. The results showed that when no motivation was used an average gain of .794 was made; when test motivation was used, an average gain of 3.028 was made, and when motivation by talks on the value of good English was used, the average gain was .692. The conclusions drawn by the experimenters were that the most important single factor in learning was the amount of repetition; that intrinsic motivation, or motivation by talks, caused no learning beyond that of the repetition; that test motivation caused learning in addition to that given by repetition; and that motivation aided learning because it made the drill palatable, led the pupil to analyze his work, called forth a better quality of attention, and caused him to put forth vigorous effort.

Characteristics of Tests and Scales Which Influence Their Use in Motivation

Records of progress should be accurate and represent as nearly as possible the actual achievement of the pupils.

[1] Symonds, Percival M., and Chase, Doris H., "Practice Versus Motivation," *Journal of Educational Psychology*, Vol. XX (1929), pp. 19–35.

They may be obtained either from teachers' marks or from measurement with a standardized scale. The value of teachers' marks is questionable. Their unreliability is indicated by the wide variation in the judgments of teachers in different schools, the variation in the judgments of teachers from the same school, and the variation in the judgments of the same teachers made at different times on the same paper. Because of this variability there is little correspondence between progress as represented by teachers' marks and actual progress. Hence teachers' marks have little value as incentives for improvement.

Standardized scales were designed to overcome these deficiencies. The first English composition scale was made by Hillegas and was published in 1912. It consisted of samples ranging in value from 0 to 937 on a scale of 1,000. An effort was made to secure equal differences between successive samples by selecting for each step a sample that seventy-five percent of the judges agreed was just better than the one before it. Naturally the scale had some imperfections, but the revisions made by Thorndike, Trabue, and Hudelson have made the following improvements: equalization of the intervals between samples so as to make it possible to say that 9 is as much better than 8 as 6 is than 5; the substitution for the artificial samples of actual ones written under school conditions; the substitution of longer compositions for the short ones so as to make it possible to judge power and sentence arrangement more effectively; the placing of several samples for each step in the middle region of the scale so as to increase the chances of accurate matching; and the selection of samples that are all on the same topic so as to eliminate errors originating in preferences for a particular subject matter.

The latest revisions of the Hillegas scale still leave some faults, especially its samples which are of the narrative type and exclude explanation, argumentation, and description. It is a matter of opinion which sample of the scale a given composition matches. Sometimes these opinions vary widely among judges. The scale measures only quality, but it leaves even that term undefined. Errors in spelling, punctuation, sentence structure, and capitalization are not evaluated separately, but only insofar as they influence undefined quality. Subject matter is ignored, although much of the value of any composition lies in its content. One of these weaknesses, the subjective element in matching, may be greatly reduced by practice. In fact, unless a user of the scale becomes trained in accurate matching before he begins to grade with it, his judgments will have little value. However, after this training, his judgment should be sufficiently accurate to measure improvement and to make comparisons between the products of individuals and of schools. Used in this manner, the scale has much value for motivating work in composition.

Motivation by Socialized Procedures

An effective stimulus for the use of language is an interested social group. In the socialized recitation an effort is made to use this stimulus in teaching language. An experiment to test its effectiveness was made by Thompson [2] on two classes from a technical high school over a period of nine weeks. One class was taught by the socialized recitation and the other by the traditional academic method. The essential features of the socialized as compared with the academic method were that in

[2] Thompson, C. J., "A Study of the Socialized Versus the Academic Method of Teaching Composition," *School Review*, Vol. XXVII (1919), pp. 110–133.

the former a pupil talked or wrote to an audience; the form of composition used was less rigorous; less emphasis was placed on mechanics; publicity was always given to a theme; attention was given to communication; and many stimuli were given for expression. These included pleasing the teacher, interesting an audience, working in a community, and doing something in a live social situation. The progress of each class was measured in five monthly tests by the number of errors per one hundred words of composition and by the scores on the Harvard-Newton Scale. Between Tests 1 and 5 the errors were 14.6 percent less for the academic class and 47.8 percent less for the socialized class. The scores on the Harvard-Newton scale increased 2.7 percent for the academic class and 11.7 percent for the socialized class. Another way of stating the difference is to observe that the academic class made only a half-year's standard gain while the socialized class made a two-year gain.

Motivation by Coöperative Teaching

An effective motive for good work in English should be found in a universal requirement for good form in order to obtain the objects of communication. We use slovenly English because we get what we want just as well as if we use good English. However, if children should be required to speak correctly in order to get what they want they would soon learn correct English. Teachers of English find their task difficult because too often their classes are the only ones in which high-school pupils are required to use good English. It is possible that the improvement in English would be greater and more widespread if all teachers insisted on good English. Hiatt [8] attempted to measure the effect of such a pro-

[8] Hiatt, Lyman Ray, *Developing Language Habits*, Master's Thesis, University of Chicago, 1925.

cedure in a high school at Independence, Kansas. The essential features of his plan were as follows:

The sophomores were used as an experimental class while the juniors were used as a control class. Each sophomore, as well as the instructors in agriculture, bookkeeping, botany, domestic science and art, geometry, history, and woodworking received a style sheet on the fundamentals of good English. All instructors emphasized the desirability of having students speak in complete sentences. The subject-matter teachers passed the themes—two hundred and thirty in number—received from the sophomores to the English teachers for marking and credit. The sophomores in English classes were urged to write on themes relating to their other courses. Five hundred and fifty such themes were received by the English teachers. Students received credit for them from their subject-matter teachers. All sophomores were required to keep in their notebooks a record of their most flagrant errors in English and of their progress in eliminating them. Extra credit was given to sophomores participating in essay contests for which local agencies offered a number of prizes. The juniors, who matched, approximately, the sophomores in ability, received only the traditional instruction in English.

The effects of this plan were measured by giving, in October, March, and May, to both sophomores and juniors the Nassau County composition tests, a spelling test, and the Charter's Grammar Test. In all the tests but grammar, a larger percentage of the sophomores than of the juniors made gains. The scores in grammar were thought to be a result of the great lead of the sophomores over the juniors at the beginning of the year, and their consequent lesser opportunity for gain. In spite of this, they made a satisfactory gain and maintained their lead

throughout the year. The largest gains were made in composition and in spelling. In composition, two thirds of the sophomores made gains, as against about one half of the juniors. In spelling, nine tenths of the sophomores made gains, as against about one third of the juniors. The absolute gains in composition and language were nearly three times greater for the sophomores than for the juniors, and in spelling, the sophomores made an average gain of 17.72 points as against a loss of 2.20 by the juniors. These large differences in favor of the students who had the responsibility of using good English in all their work make an excellent case for coöperation by all teachers in urging students to use good English.

Additional evidence of the value of coöperation is furnished by Church,[4] who directed a coöperative plan for English in the high school of Cicero, Illinois. The principal feature was the submission by each non-English teacher to the English department of a grade for the work in English done by each student in his subject. The average of these marks counted one fourth for the semester grade in English composition. For the guidance of the teachers, there was a set of general directions which stated the requirements in oral and written English. These requirements included the use of complete sentences in recitations; careful pronunciation; avoidance of such introductory words as "why," "well," "oh," and so on; non-use of slang; use of balanced margins, indented paragraphs, correct capitalization, correct placement of periods, and correct commas for series; avoidance of stringy sentences; and legibility. The results showed that this plan helped the English grades of poor English students and reduced somewhat the English grades of students good in English, a result which no

[4] Church, H. V., "An Experiment in Coöperation in English," *School Review*, Vol. XXIII (1915), pp. 670–678.

doubt followed partially from the habit of subject-matter teachers of using less discrimination in grading English than they did in grading the work in their own fields.

Motivation by the Selection of Interesting Topics

That the nature of the topic makes a large difference in the quality of the composition was shown in Hudelson's [5] investigation in which thirty-two topics were assigned to each of seven hundred and seventy pupils in Grades VII to XII, inclusive. In selecting the topics an effort was made to choose those which would interest the pupils and which would be typical of those widely used and recommended. It was found that the topic, "A story based on a picture," yielded a composition having the standard of Grade X, while the topic, "Did it happen right in church?" yielded one having the standard of Grade IV, a difference of six grades. In Grade VIII, the topic, "A description of camping," yielded a composition having a standard of Grade X *A*, while the topic, "An argumentation on school," yielded one having the standard of Grade VII *A*. In Grade IX, the topic, "The most exciting ride I ever had," yielded a composition having the standard of Grade XI, while the topic, "Relate an interesting story which you have heard," yielded one having the standard of Grade VII. In Grades X and XI, the topic, "How I learned a lesson," produced compositions that were four grade-years beyond such topics as, "Relate an interesting story which you have heard," and "What I should like to do next Saturday." In these examples, the best topic resulted in a composition that was from two to three grade-years above the standard for the grade, while

[5] Hudelson, Earl, "English Composition: Its Aims, Methods, and Measurement," *Twenty-Second Yearbook of the National Society for the Study of Education,* Part I, 1923.

the poorest topic yielded one that was from two to three grade-years below that standard.

The most probable explanation for these variations lies in the relation which the topic has to the pupil's background of experience. If a pupil writes on a topic with which he has had vivid and definite experience, he can write well; if the topic is comparatively foreign to him, he writes poorly. A pupil from Grade VII can write a good story about a picture because he needs only to describe what he sees and add a little imaginative interpretation; but he writes poorly about "Did it happen right in church," because little or nothing exciting ever happened to him in church. Pupils from Grade VIII can write well about "Camping," for most of them have had pleasant and recent experiences with camping, but they write poorly about "School," because they have not thought of schools as social institutions or of their value to society. Similarly, pupils from the senior high school can write well on how they learned a lesson because all of them have had definite experiences in learning lessons, but they write poorly on the topics, "Relate an interesting story," or "How I should like to spend the next Fourth," because at the moment no definite experiences are suggested by these titles.

According to these results, it seems that pupils find motives for writing on topics about which they have had vivid experiences, or which require only a description of what is before them, or which necessitate no prolonged search for materials. This is true at least for compositions which must be written on the spot, without previous notice and within a short time limit.

Writing on topics relating to local history, and dramatizing them, were found by Reavis[6] to change the at-

[6] Reavis, W. C., "An Experiment in the Teaching of High School Composition," *School Review*, Vol. XXI (1913), pp. 538–541.

titude of students toward theme-writing from indifference and boredom to pleasure and privilege. He assigned to the English pupils of his high school the task of working up the pioneer history of their community in the form of reports on specific topics, using the old citizens as important sources of information. When that had been done, the results were worked into an historical play in which forty-two characters took part and to which the old citizens were invited. Besides changing their attitude toward theme-writing, this activity, according to Reavis, also taught the students methods of work that would make future writing easier, enabled them to find a compelling motive in the worth-whileness of the task, and through coöperation enabled them to learn just what was expected of them. The encouragement received from the community and the opportunity to share in the play stimulated their best efforts.

Allowing and encouraging high-school pupils to write and read about problems disturbing their own lives was found by Block [7] to be an effective means of vitalizing an interest in English composition. She worked with pupils a third of whom were repeaters and half of whom preferred to drop the subject because they could not see any value in having to make a speech before the class, and disliked reading the books they had to read and having to listen to poetry they could not understand. A change of attitude resulted when they were permitted to change from the systematic study of the classics to the selection of their reading and writing from the field of such vital problems as, "The problem of getting along with your family when their ideas are a century behind yours," and others equally disturbing. Standardized

[7] Block, Virginia Lee, "Can We Vitalize English? A Controlled Experiment with Two Methods in Literature," *English Journal,* Vol. XXV (1936), pp. 638–652.

tests in English showed that this group made about one third more gain during a semester than an equated control group which preferred to work, as a group, on the elements of composition and literature.

The foregoing studies indicate that the most effective topic for a composition is one which interests the writer. Thus, the compositional interests of high-school pupils become a matter of great importance.

Harris,[8] who investigated the compositional interests of junior high-school pupils in topics related to school subjects, found the order of preference to be biography, history, actual personal experience, manual training and cookery, imaginary personal experience, other imaginary experience, other actual experience, literature, and geography. According to Coleman,[9] who investigated the compositional interests of both junior and senior high-school pupils regardless of their relation to school studies, their major interests were in adventure, sports, and travel. Both boys and girls liked these three topics, as well as those on outdoor activities, athletics, ethics, personal experiences, literature, humorous anecdotes, sympathy, animals, home life, pupil employment, and leisure activities. Both disliked topics on sentiment, children, health, handwork, social problems, science, fairy tales, civics, proverbs, art, winning of prizes, and machines. The reasons most often given for their preference in topics were that they liked them and that they had special information about them. In regard to form of composition the order of their preferences was friendly letter, argument, description, and narration. Their prin-

[8] Harris, James H., "An Inquiry into the Compositional Interests of Pupils in the Seventh and Eighth Grades," *English Journal*, Vol. II (1913), pp. 34–43.

[9] Coleman, J. H., "Written-Composition Interests of Junior and Senior High-School Pupils," *Contributions to Education*, No. 494. Teachers College, Columbia University, 1931.

cipal dislikes were poetry, business letters, editorial essay, and exposition. These studies suggest the importance of giving wide latitude to the pupil in regard both to his topic and the form of his composition.

Motivation by the Selection of Socially Useful Activities

Probably the most effective type of motivation for the development of language habits is to have the pupils engage in socially useful activities; that is, those language activities most frequently used in meeting life's situations. What these activities are was made the object of an investigation conducted by Baker,[10] Clapp,[11] Johnson,[12] and others. A report of their findings will give us an idea of the principal language activities in which the school should give training.

Investigations of forms of communication. In Baker's investigation the children of the elementary schools of Dallas, Texas, were asked to make lists of the things they did outside of school about which they need to talk or write. Of the returns received 200 papers were selected from each grade from Grade III to Grade VII, inclusive. The principal uses of spoken English in their order of frequency were as follows: conversation; business; courtesy; games; telephoning; church and Sunday school; reading aloud; asking and answering questions; entertaining or teaching children; story-telling; club meetings; speeches; jokes, riddles, and jingles; praying; quarreling; announcements. In writing, the principal

[10] Baker, Elizabeth W., "A Social Basis for Teaching of English Elementary Language," *Elementary School Journal*, Vol. XXX (1930), pp. 27–34.

[11] Clapp, John M. (Editor), *The Place of English in American Life.* Chicago: National Council of Teachers of English.

[12] Johnson, Roy Ivan, *English Expression: A Study in Curriculum-Building.* Bloomington, Illinois: Public School Publishing Company, 1926.

uses are letters, stories and poems, business forms, lists of groceries, telegrams, reports, advertisements, diaries, signs, and posters.

Clapp's investigation was conducted by a committee of the National Council of Teachers of English by means of a questionnaire sent to adults. Replies were received from 1335 college students, 703 high-school graduates and 577 elementary-school graduates. The principal uses of spoken English in order of frequency for college graduates were as follows:

Conversation:
- With strangers
- Over the telephone
- At social gatherings

Interviews:
- Collecting information
- Business conferences

Writing:
- Notes, record, etc.
- Notes of invitation, etc.
- Business letters
- Reports of meetings
- Instructions.

Johnson interviewed 104 college women of the freshman class for the purpose of finding the most frequent language activities. The highest 22 in order of frequency were as follows: conversing; writing letters; relating incidents, telling stories, and so on; keeping a diary; telephoning; engaging in group discussion; writing invitations and replies; giving talks; keeping accounts; writing telegrams; giving directions; teaching a Sunday-school class; entertaining guests; doing club work; acting as secretary; making out reports; setting an example in the use of English; taking part in an entertainment

program; meeting and introducing people; and making a report to a group.

According to these investigations the principal uses of spoken English are in conversation, telephoning, expressing courtesies, conducting interviews and engaging in group discussions; and of written English, in letter-writing, note-taking, writing invitations, writing reports, writing instructions, writing lists, and writing telegrams. If the English curriculum is to have the greatest practical values, it should select such exercises and materials as will develop skill in these activities.

Controlling principles in the selection of content. Since the art of communication is a matter of habit, the controlling principles in selecting the content should be the laws of habit formation, and should include practicing good English on every occasion, permitting no exceptions, correcting errors, and obtaining satisfactory rewards for the use of good English. To carry these principles into effect every teacher, no matter what his special subject may be, must be a teacher of English and insist that his pupils practice it. He must call attention to errors made and give examples of correct forms. To make satisfactory rewards possible, every teacher of subject matter other than English might give a double grade, one for achievement in English and one for achievement in subject matter. The English teacher might determine the grade in English partly on the basis of achievement in English in courses outside of the English department. To the writer, the system of withholding credit in freshman composition until the junior or senior year and then granting credit only if there is evidence of well-established habits in the use of good English, appears to be an effective type of motivation for using good English on all occasions.

Some Courses of Study Based on Expressional Activities

If the principles stated above are correct, the center of the curriculum in English composition should be an expressional activity rather than emphasis on rhetoric and grammar. Some recent courses of study have been made on this basis, including those of West Virginia, Denver, Colorado; and Highland Park, Michigan. The West Virginia course prescribes conversation and business letters for Grade VII; discussion and social letters for Grade VIII; speech-making, business and social letters for Grade IX; story-telling and explaining for Grade X; arguments, reports, petitions, announcements, and so on, for Grade XI; and literary types of language, such as orations, essays, descriptions, verse-making, and so forth, for Grade XII. Both in Denver and in Highland Park the work in English composition consists entirely of expressional activities in the junior high school. In Highland Park six classes of activities are emphasized in each of these grades, namely: (1) conversation and discussion, (2) announcements, reports, and speeches, (3) instructions, directions, and explanations, (4) story-telling, (5) written explanations, stories and poems, and (6) letter-writing.

The advantage of such a curriculum is that it develops habits. Its disadvantage is that it may fail to give the pupil a basis for self-criticism and for working out correct forms independently. Such a basis is found in the study of grammar; on this account, it would appear helpful to study some functional grammar along with the expressional activities. If the emphasis is kept on the expressional activity, the experiment of Symonds[18] supplies a justification for believing that a combination of

[18] *Loc. cit.*

expressional activity with the study of grammar is a better course than either alone. But an effort must be made at all times to determine what is functional grammar and to make those elements function.

Summary

A fruitful source for improving one's language habits is found in the use of compelling motives in writing and speaking. The principal types of motivation that may be used for this purpose are mastery motives, social motives, the selection of interesting topics, and the selection of socially useful language activities.

Appeals to mastery motives may be made by records of progress based upon measurement by objective tests. Teachers' marks may also be used, but they have been found to be unreliable because of their wide variation, a factor, however, which has been greatly reduced by the use of objective tests and scales. Language scales have been greatly improved since their introduction, but they still contain many faults. However, they are more accurate than the unaided judgment of the teacher.

Social motives may be used effectively in socialized procedures where the stimulus is to say something that will interest the social group, or in connection with dramatization where the stimulus is an opportunity for display in performing a drama, or in coöperative teaching where the stimulus is the assignment of a good grade as a partial reward for the use of good English.

Interesting topics have been found to yield much better compositions than uninteresting ones.

Another source of motivation is the selection of socially useful language activities. In spoken English, these activities have been found to be conversation, telephoning, expression of courtesies, and group dis-

cussion. In written English, they have been found to be letter-writing, note-taking, writing reports, writing instructions, and writing lists. The principles of selection were expressional activities rather than principles of rhetoric and grammar.

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CHAPTER 6

English Literature: Objectives and Organization

Objectives and Values

Sixteen current writers on objectives. An analysis of the opinions of sixteen[1] current writers on the values and objectives of the study of literature discloses that its values may be classified into the following groups: utilitarian, informational, inspirational and moral, recreational, and aesthetic. The specific values in each group are shown below:

[1] Among them were the following:

Abbott, Allan, "The Aims of High School English," *English Journal*, I (1912), pp. 509–511.

Aydelotte, Frank, "English as Training in Thought," *Educational Review*, XLIII (1912), pp. 345–377.

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Breck, Emma J., "A New Task for the English Teacher," *English Journal*, I (1912), pp. 65–71.

Cross, E. A., "Literature in Everyday Life," *Education*, XLIII (1922), pp. 216–227.

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Reynolds, Geo. F., "Aims in the Teaching of Literature," *English Journal*, Vol. XXI (1932), pp. 358–364.

Utilitarian:

Correct use of English in speaking and in writing.
Command of the art of expression; mastery of style.
Skill in cursory, careful, and consultative reading.
Improved ability to think.
Wider range of thought.

Informational:

Greater knowledge of words.
Knowledge of nature and humanity beyond limits of observation.
Better interpretation of life.
Knowledge of biographies of authors.
Knowledge of history of literature.
Recognition and understanding of quotations.
Knowledge of types of literature.
Appreciation of the life of other ages.

Inspirational and moral:

Assistance in forming ideals.
Assistance in making reading a positive force for good.
Organization of emotions on rational basis.
Development of altruism, self-reliance, self-respect, and independence.
Elevation of reader above daily existence.
Development and humanization of character.
Self-analysis.

Recreational:

Entertainment for leisure.
Appreciation of current literature.
Development of the art of good conversation.
Companionship in good books.
Enjoyment in good books.

Aesthetic:

Development of liking for good reading.
Appreciation of good books.
Insight into literature as the expression of principles of art.
Development of the beauty and significance of life.
Development of discrimination between good and bad literature.

The writers who stated the above values and objectives did not mention the order of their importance, but if frequency of mention or emphasis is an indication, we may say that teachers emphasize most the moral and inspirational values. Although they undoubtedly spend

most of their time on the informational values, students emphasize mostly the recreational values, while authors regard the aesthetic values as most important. From the standpoint of teaching we must pay much attention to the reader's views and also to the possibility and ease of attaining these values. Our next step will therefore be an examination of the validity of each of these objectives.

Sources of information that will help us formulate judgments on the validity of the objectives of literature are reports of achievement in the various branches of the study of English, quantitative studies of books read voluntarily by students, and withdrawals from libraries. Where these references are lacking we must depend on speculative reasoning from psychological principles.

Utilitarian Values

Composition. The utilitarian values, insofar as they relate to skill in oral or written composition, have already been sufficiently discussed. Here it need be emphasized only that the study of literature may help composition in two ways, namely: (1) in supplying food for thought and (2) in furnishing ideas about technique and form of expression. But unless literature is studied specifically with respect to these goals and unless the knowledge so gained is followed by practice, we may expect no improvement in composition. Reading literature for enjoyment will in itself not produce skill in composition. The study of literature will be accompanied by a development of skill in reading because the latter is a condition of its success. Literature must be comprehended before it can yield any values, and comprehension implies skill in reading. If the student's skill in reading is deficient, the teacher must develop it, but when he does,

he is teaching something other than literature. Because of the importance of reading ability in studying literature we shall later discuss how this skill may be developed. The other utilitarian values of the study of literature—acquirement of the ability to think and extension of range of thought—should not be considered peculiarities of the subject but rather as values that may be derived from this subject matter as well as from others.

Skill in reading is a prerequisite and is a legitimate objective of the study and teaching of literature only in special cases, while the development of thinking ability and the extension of the range of thought are disciplinary values that may be obtained from the serious study of any subject. Our conclusion would therefore be that the utilitarian objectives are hardly valid for the teaching of literature, although it may be studied for these purposes. In our judgment, these goals can be much more effectively attacked in the teaching of composition.

Informational objectives. The informational objectives of the study of literature are not only valid, but are indispensable for its comprehension and appreciation. The reader must know the meaning of the words in order to understand them; if he doesn't, he must learn them. The acquirement of a knowledge of nature and humanity beyond the limits of observation is a legitimate objective of any reading; if this objective is not taken in a scientific sense, it is the primary purpose for reading any but recreational literature. The acquisition of this enlarged knowledge naturally gives a deeper insight into and a better interpretation of life. A knowledge of the biography of an author often throws light on his productions, which in many cases are chapters out of his life and always are outgrowths of his experiences

and observations. The same is true of a knowledge of the history of literature, for every literary composition is in part a product of its environment, an outgrowth of the work of previous writers and a reflection of a mode of thought current at the time of the author. The ability to identify quotations, and a knowledge of the types of literature are incidental by-products of reading for its major purposes, the extension of experience and enjoyment. Any reader will soon discover that fiction, poetry, and drama are usually more suitable for recreation and that essays or nonfiction books are better for the acquisition of information. A serious study of types as such is unimportant except for purposes of composition.

Although the informational objectives are logically valid, there is evidence to indicate that they are poorly realized. It is probable that teachers regard informational items as unimportant or that they do not make their mastery an objective of instruction. The results of standardized tests point in this direction. This may be seen from the mean scores for Parts III and IV of the Columbia Research Bureau English Test, on vocabulary and literary knowledge, respectively. Each of these tests consists of words that occur principally in literature, as: *traverse, lyrical, specific, synonymous, wan, dialectic, racy, plethora, transpire,* and *bespeak.* The test of literary knowledge is a completion test requiring the identification of literary characters, quotations, and titles, such as: Captain Hook, "All the world's a stage," John Gilpin's ride was on a——, Dr. Jekyll and Mr. Hyde were ——, *Paradise Lost,* the *Nun Priest's Tale,* and Falstaff. The average number of correct items given by 1,352 freshmen in Columbia and Barnard Colleges was 63 for the vocabulary test and 38 for the test of literary knowl-

edge. Because of the excellent high schools from which these students came, it is probable that these scores are higher than those that would be made by the average college freshman.

Character development. The achievement of the objectives of literature which center around character development is difficult to measure, both because of the disagreement as to what character is and the difficulty of assigning definite causes for the development of character, even if it is agreed that an individual has attained this end. Whatever the results may be in regard to character development, it is possible to explain them by a large number of factors, such as heredity, home influence, other studies, and the various factors involved in an individual's life of play and leisure. If we disagree as to what character development is and what produces it, there is no way of estimating the influence of a teacher or of a subject in this direction. However, we may make a hypothetical definition of character and then consider the claims made for the study of literature as a means of attaining this result.

Character may be thought of as a mode of action: a certain uniformity in an individual's reactions which makes it possible to predict what his reaction to a particular situation is likely to be. This uniformity may be described as weak, strong, vacillating, stable, shiftless, conscientious, slow, quick, flighty, persistent, dishonest, honest, bad, good, and so on. For example, we may say an individual has a weak character if he has good intentions, but doesn't carry them out; and a strong character if he not only formulates a purpose, but persists in achieving it. A man is said to be honest when he is truthful and meets his obligations, and dishonest when he fails in these respects. Character development might

be thought of as a process of acquiring some characteristic in one's reactions to a certain class of situations, but as a matter of fact, it is limited to the acquisition of the desirable qualities.

If character is a mode of action, it can be acquired by maintaining a certain standard of conduct. The possibilities of character development through the study of literature are then determined by the extent to which this study leads to changes in conduct, or rather to the systematic practice of the types of conduct suggested by the study of literature. From this point of view, we will at once agree that literature is not studied for this purpose. Lessons in literature are not followed by systematic exercises in types of conduct. The teacher considers that his task is completed when he has succeeded in interesting his pupils or in having them answer some questions about a selection. That is, literature is something to be read, comprehended, enjoyed, and memorized in part. The reactions that are provoked by it are thought-getting reactions. But the acquisition of ideas cannot really be said to influence character until the ideas produce creative thought and until the thought is followed by conduct appropriate to it, and furthermore, not until the appropriate conduct becomes habitual. As a matter of fact, the acquisition of the ideas in a piece of literature is considered to be the end of a student's responses to it. If so, it is clear that they do not noticeably influence the reader's character. There is, of course, the possibility that the acquired ideas lead to creative thought and eventually to a new type of conduct, but the probability is small—so small that character development can never be a major objective of the study and teaching of literature, although it certainly may be a contributing factor.

In the light of this discussion, we may refer to the possibilities of character development from the study of certain selections, as for example, Scott's *Lady of the Lake* and Emerson's *Self-Reliance.* One writer says that the study of *Lady of the Lake* is of inestimable value in dignifying, rationalizing, and purifying the emotion of sex. An examination of the poem reveals that the number of lines referring to love is very small. There is almost no reference to courtship, and although the princely Malcolm wins the fair Ellen, this comes as a surprise to the reader, who expects the Knight of Snowdown to win her because of the much larger number of lines that the poet has devoted to describing his attentions to her. Most of the poem is given to an account of warfare between outlawed clans and the king's forces, the most important part of which concerns a life-and-death fight between the king and one of the chiefs. Other parts of the poem describe a deer hunt, a fight between two chiefs who are rivals for the hand of Ellen, and a festival in which there is some expert shooting with a bow and arrow. About the only sex behavior that is described is one slight blush by Ellen, a proposal to her by Roderick, which her father refuses, and the fight between the rival lovers. The poem is silent about the nature of sex emotions and reactions and about means of controlling them. To inject a discussion on this topic while studying the poem would be flying off on a tangent and would seriously interfere with the appreciation and understanding of the poem.

An attempt to develop the trait of self-reliance from the study of Emerson's essay on that topic is much more appropriate than an attempt to develop sex morality from *Lady of the Lake*, for the former sticks to the subject and preaches the cultivation of this trait. A

teacher might persuade a young student to make the following the motto of his life: "Nothing is at last sacred but the integrity of our own mind. Absolve you to yourself and you shall have the suffrage of the world." However, the young student might be more impressed by the following: "If I am the devil's child, I will live then from the devil. No law can be sacred to me but that of my nature." If so, this might justify a life of crime, which would be quite foreign to the purpose of the essay. Most likely the study of the essay will not influence the student's character one way or the other. His most probable reaction will be that Emerson makes out a strong case for his subject. If he is inclined to independence of thought and action, the study of the essay will convince him that his character is right; if crime appeals to him, he can find something in the essay to justify his views. That is, the good man will find good things in literature and will learn how to become better, and the bad man will find something bad and will learn how to become worse. Conduct makes character, and ideas will influence character if they are translated into conduct, but this step rarely results from the study of literature.

Recreational and aesthetic objectives. Reading for recreation is the objective that appeals most to high-school students. In 246 papers which Gosling received from high-school seniors on "The benefits which I should like to derive from the study of English," there were 328 mentions of recreational benefits, 256 mentions of training benefits, 241 mentions of instructional or informational benefits, 233 mentions of disciplinary benefits, 84 mentions of interpretative benefits, and 21 mentions of inspirational and moral benefits. The striking fact here is that recreative functions come first, with 328 mentions, while moral objectives come last, with only 21 mentions.

These figures may be taken as an index of the relative importance which high-school students attach to these two classes of objectives, and are supported by all studies of the voluntary readings of children and of students. They show that fiction or some form of imaginative composition constitutes the bulk of their reading material. In view of this fact, it would appear that the recreational values of the study of literature are the ones that should be emphasized. Such an objective has great social value. The worthy use of leisure time is considered to be one of the great aims of education, and rightly so, for studies of crime have shown that one of its most important single causes is the activities in which a youth engages during his leisure hours.

Aesthetic values for those who can appreciate them may be classified with the recreational as an important objective in literature. If students develop the ability to discriminate between good and poor literature, if they see literature as an expression of principles of art, and if it opens to them the beauty and significance of life, they are getting its best values. However, we should not expect all students to attain them.

We may conclude that the following should not be major objectives of the study of literature: correct use of English in speaking and in writing, improved ability to think, and development of moral character. The study of literature may aid in the attainment of these objectives, but to make them primary is likely to prove disappointing. Composition is an art and is better studied as a separate subject. All studies may contribute toward improvement in ability to think and toward widening of the range of thought, but these objectives are not peculiar to literature. Likewise all studies may contribute to development of character, but we know so

little about how this end may be attained that it is best for the teacher of literature to regard it only by avoiding selections which contain degrading suggestions.

The realizable objectives of the study of literature are to learn to read it for enjoyment and entertainment, to appreciate its aesthetic values, to get a vicarious experience in all phases of life, and to increase the reader's information about words, authors, types of literature, nature, and life. The information about words, authors, and types should be exact, but not so the information about nature and life, for literature is not a natural science. The informational items in literature are important chiefly as a means to its complete comprehension and enjoyment. To learn to use literature as a leisure occupation is its most socially valuable objective. The highest values are aesthetic, but these are not attainable by all.

Organization

We may interpret the principle of organization to mean that form of learning in which improvement is due to increased understanding or insight. As applied to literature it means the comprehension of the thought, but it may also mean the perception of a sound pattern, such as the rhythm and melody in a poem; or the formation or perception of emotional patterns, the portrayal of which is the objective of some literature; or the formation of an intuitive pattern, such as an esthetic experience that is dwelt upon for its own sake. All of these are different ways of appreciating literature.

Factors Involved in Appreciation

An analysis of factors involved in the appreciation of literature is to some extent a subjective undertaking, but

we may presume that among them are the following: (1) comprehension or ability to read, which includes adaptation of selection to the intelligence and interest of the reader, adaptation of the vocabulary to the reader's knowledge, correlation of the subject matter to the reader's experience, and a number of other factors; (2) imaginative power, or the ability to get pictures and other images from words; (3) appeal to the interest of the reader; (4) practice, by which is meant that literary appreciation is developed by exercises in reading literary selections; (5) perception of rhythm and rhyme; (6) knowledge of technical devices, such as sentence structure, rhythm, alliteration, and figures of speech; (7) some familiarity with the author's subject matter, or in other words, a wide experience; (8) a sympathetic attitude toward the author and the selection; and (9) recognition of a personal relationship between the author and the production. It is the purpose of this section to discuss these factors insofar as investigations permit.

Just how important these and other factors are to the appreciation of literature is not clear, partly because there has been a scarcity of experiments in these problems and partly because the measurement of literary appreciation is still undeveloped. Scientific studies in literature are scarce because many teachers of literature are not only untrained in scientific methods, but are hostile to them, and feel that reducing literary values to statistical terms is destroying them. The same objections to the study of botany used to be made by lovers of flowers, but botanists not only enjoy flowers but even make use of their scientific knowledge for developing more beautiful flowers. Some teachers of literature also take this view and believe that through scientific experiments in methods of teaching literature, we may discover

ways of developing more effectively in pupils an appreciation of the beauties of literature.

Because of this scarcity of scientific studies we shall limit our discussion of the teaching of appreciation largely to three phases, namely: reading ability; appeal to the interest of the reader, or motivation; and practice. The last will not be treated as a separate topic but rather as a method by which we increase reading ability, or interest.

Improving the ability to read. It is evident that before we can appreciate a literary selection we must comprehend it. If comprehension is lacking, then our first task should be to improve the ability to read. That there is great need of improving the reading ability of high-school students is shown in an investigation by Irion,[2] who studied the extent to which 170 pupils from Grade IX comprehended the fundamental meaning of Cooper's *The Spy*, Byron's *The Destruction of Sennacherib*, Shakespeare's *Julius Caesar*, and Darwin's *The Origin of Species*. His tests showed that the comprehension of *The Spy* was 60.10 percent; of *The Destruction of Sennacherib* it was 38.55 percent; of *Julius Caesar* it was 44.50 percent; and of *The Origin of Species* it was 60.50 percent. The average comprehension of all of these was about 50 percent. With this degree of comprehension of a selection, it seems useless to expect much in the way of enjoyment or appreciation of literature. It is equally futile to go on the assumption that high-school pupils can read well and that all that is necessary to develop appreciation is to expose them to a wide reading of good selections. Before appreciation can be developed

[2] Irion, Theo. W. H., "Comprehension Difficulties of Ninth Grade Students in the Study of Literature," *Contributions to Education*, No. 189 (1925). New York: Teachers College, Columbia University.

it is necessary to see to it that pupils have the necessary reading ability.

To find ways of improving reading ability it is necessary merely to select those devices which experiments have shown to be effective in teaching comprehension to pupils in the grades. It is reasonable to suppose that it can be improved by removing the difficulties that interfere with it. Among these may be mentioned irrelevant or free associations, irrelevant preconceptions, habitual responses, perseveration, inability to form clear sensory images, lack of experience, flighty attention, and lack of effort. To overcome these difficulties, it is necessary to develop a proper background in the reader, to direct his attention to the theme and the important questions in the selections to be read, to direct him to interpret words in a sense that fits the context, to have him dwell on scenes long enough to form images of them, to have him talk about the new theme long enough to divert his attention away from former unrelated activity and to center it upon the new topic, and to develop in him a favorable mental set. Some ways of doing this are (1) using interesting selections within the reader's experience; (2) giving advance questions on the content; (3) giving advance explanations of content; (4) giving printed directions requiring a response either by word or action; (5) calling attention to the central thought; (6) finding solutions to problems; (7) reproducing story after reading; (8) testing content by questions; (9) testing content by completion, true-false, selection, and matching exercises; (10) dramatizing story; (11) sketching interesting scenes in story; (12) analyzing and describing qualities of characters; (13) explaining new words in reading; (14) writing a summary or outline of the main points in a story; (15)

giving systematic and supervised practice to points in which specific weakness is found. We shall give a few illustrations of the effectiveness of the above and of other procedures by referring to some experiments that were made on high-school students.

The first experiment to be discussed is one that was made by McCarty,[8] who selected two equivalent groups, one experimental and one control group from Grades IX and X, by the Iowa Silent-Reading Tests and the Otis Self-Administering Tests of Mental Ability. The experimental group received training in overcoming the difficulties that were revealed in the reading tests, while the control group received no training in reading. The procedure with the experimental group was as follows: on Monday, Wednesday, and Friday of each week the pupils were instructed to read for a definite purpose. After the assignment was made, they were left strictly alone. Emphasis was placed on getting the central thought of an entire article, finding descriptive words or phrases, making summaries, understanding cartoons, skimming for general information, re-reading to find incorrect and incomplete sentences and misspelled words, and reading to find answers to thought questions. The pupils' abilities in the specific reading skill sought were tested daily by means of objective tests. Each pupil kept a chart of his daily progress, his goal being to keep the curve at ten, the maximum number of points that could be made on each test. The materials used were selected from magazines and newspapers, and represented several grades of difficulty. On Tuesday and Thursday each pupil read during the class period a book of his own choice; the teacher checked the number of pages that were read

[8] McCarty, Pearl S., "Increasing Comprehension in Silent Reading," *School Review*, Vol. XXXIX (1931), pp. 758–767.

at these times. Before and after the experimental period, the Iowa Silent-Reading Tests were given to both groups. The results showed that the experimental group raised its average score from 94.9 to 136.9, a gain of 44.3 percent, and that the control group raised its average score from 93.8 to 122.4, a gain of 30.5 percent. The excess gain made by the former group should be attributed to the influence of the special training.

Other experiments showing how the comprehension of literary selections may be improved were made by McCallister and Baker,[4] McCullough,[5] Miller,[6] Gibbs,[7] Salisbury,[8] Barry and Pratt,[9] and others. A variety of devices were found helpful by these investigators. Among them were: training in reading for self-entertainment, training in oral reading, training in the efficient use of books, giving selections of prose or poetry followed by questions on the main ideas, directed free reading of interesting material accompanied by frequent check-ups by means of oral conferences and objective tests, and outlining. In order not to make the story too long more details will be given only of the experiments of Barry and Pratt, and of Salisbury.

Barry and Pratt selected poor readers from Grades VII to XII by means of a test which checked both power and speed. Those in the junior high school who were a year below the norm for their grade, and those in the senior

[4] McCallister, James M., and Baker, Grace H., "Corrective Instruction in a Seventh Grade English Class," *English Journal,* Vol. XXII (1932), pp. 734–743.

[5] McCullough, Constance, "Improving Reading Comprehension in Grade IX," *School Review,* Vol. XLV (1937), pp. 266–273.

[6] Miller, Georgia E., "A Technique for Developing Comprehension in Literature," *English Journal,* Vol. XXIII (1934), pp. 810–818.

[7] Gibbs, Elsie Frances, "Remedial Work through Free Reading," *English Journal,* Vol. XXIII (1934), pp. 827–831.

[8] Salisbury, Rachel, "Some Effects of Training in Outlining," *English Journal,* Vol. XXIV (1935), pp. 111–116.

[9] Barry, Linda, and Pratt, Marjorie, "A Remedial Reading Program in Public High School," *School Review,* Vol. XLV (1937), pp. 17–38.

high school who were below the norm for Grade IX were regarded as in need of training and were given a diagnostic test, the results of which were further checked by comparison with report-card marks in academic subjects. The pupils were organized for the most part into classes of five or six so as to make possible individual instruction, which was given an hour a day until the deficiencies were remedied. A list was made of all the deficiencies revealed by the standardized tests and was supplemented by lists of deficiencies in study procedures discovered in the classroom and of those discovered by the remedial-reading teacher after treatment began. The first step in the treatment was to establish earnest attitudes on the part of the pupils and create a willingness to work for improvement. When this had been done, the following types of material were used: (1) type lessons in school subjects, consisting of selections preceded by directions for reading and followed by questions on comprehension; (2) exercises from standard work books in reading such as the McCall-Cook-Norvell workbooks and the Brueckner and Lewis Exercises in Reading; (3) exercises for increasing vocabulary; (4) exercises for increasing span of perception and speed of reading; and (5) extensive reading outside the classroom. The results showed from one and a half to four years' improvement in different grades. In general, the higher the pupil's grade classification, the less was the amount of his gain. These gains were made in each of the phases of reading tested: details, vocabulary, central idea of paragraph, sentence meaning, and rate of reading.

In Salisbury's experiment, 474 pupils from Grades VII, IX, and XII were divided into experimental and control groups for the purpose of evaluating training in outlining. Thirty lessons in outlining were given to the

experimental group. These emphasized comprehension of the primary relationships among ideas (independence, dependence, and equality), familiarity with the simple types of organization (logical, chronological, and arbitrary), and practice with devices of language which show progress from one idea to the next (first, second; a, b; one, another; in addition, finally, and so on). Standardized and informal tests given before and after the experiment showed that the differences in gain between the experimental and control groups were large and significant in reading comprehension, reading speed, reasoning, and achievement in such school subjects as history, civics, and science. Salisbury concluded that outlining, if thoroughly taught, brings valuable dividends in improved scholarship as well as in reading and in reasoning.

The value of extensive and intensive reading. The customary method of studying literature is to study it intensively and analytically. For example, it is not unusual for a high school teacher to spend six weeks on Scott's *Lady of the Lake.* Although this method may give the pupil a good knowledge and understanding of the selection studied, it often defeats the purpose of studying literature—the creation of appreciation and interest in further reading and study. To attain this objective, the extensive method is thought by many teachers to be more appropriate. Experiments on the comparative values of the two methods have been made by Coryell,[10] Williams,[11] and Rhodes.[12] Coryell's experiment was conducted with

[10] Coryell, Nancy G., "An Evaluation of Extensive and Intensive Teaching of Literature," *Contributions to Education,* No. 275. New York: Teachers College, Columbia University, 1927, pp. 8–202.

[11] Williams, Ralph R., "A Comparative Study of Extensive and Intensive Teaching of Literature in the Ninth Grade," *School Review,* Vol. XXXVI (1929), pp. 666–678.

[12] Rhodes, Luke C., "Systematic and Remedial Training for Pupils of Superior Reading Ability," *Elementary School Journal,* Vol. XXIX (1929), pp. 771–773.

nine classes from Grade XI in a high school in New York City. Three classes were taught by the extensive method, three by the intensive method, and three by undirected methods. The purpose of the extensive method was to read by wholes instead of by parts, to grasp the meaning of the whole, to lead pupils to discuss voluntarily their likes and dislikes, and to let them find in literature the expression and the enrichment of their own experiences. In studying *Idylls of the King,* pupils read significant passages aloud, gave reasons for liking certain passages, answered questions that summed up characteristic features of the whole epic, gave attention to the contribution of each idyll to the whole epic, and made comparisons with other poems such as *Lancelot and Elaine, The Lady of Shalott,* and many others. All but one of the Idylls and from three to five thousand lines of other Victorian poetry were read. In the intensive class, attention was given to detailed questions on the progress of the action, the retelling of short incidents by students, descriptions, allegorical interpretations, meaning of words, choice of words, figures of speech, analysis of character, and emphasis on parts instead of on the whole. Instead of reading all but one of the Idylls, only four were read, but these were studied in detail. In each method, the teachers tried to reach certain objectives agreed upon in advance of the study. Six types of literature were studied during the year by the two procedures, the extensive class reading six times as much as the intensive class. The results of the investigation showed that the two groups were equal in knowledge of details of specific pieces of literature and in their ability to apply methods of study to new pieces of literature. The pupils using the extensive method were superior in readiness and rapidity of expression, in participation in class, in expression

of their own opinions and preferences, in correlation of ideas in literature with their own experiences, in comprehension of the theme as a whole, in facility of general literary criticism, in appreciation of characters, and in interest in the subject. The pupils using the intensive method were superior in knowledge and comprehension of verse forms, poetic qualities, figures of speech, literary allusions, and the like.

The experiment of Williams was conducted for one semester with six classes from Grade IX in a Chicago high school. The comparative value of the two methods was measured by informal tests of the pupil's knowledge and comprehension of the basic parts of the course, by Monroe's Standardized Silent Reading Tests, Inglis Tests of English Vocabulary, stenographic reports of recitations, anonymous pupil comments, and records of the reading done. The tests in the early part of the semester resulted for the most part in favor of the intensive method, but later in the semester, they favored the extensive method. However, in only two tests were the differences significant. There were no marked differences in the vocabulary and reading tests. The stenographic reports indicated that the pupils using the extensive method discovered more material that had interest and meaning for them, that they had a greater store of ideas, a greater intensity of interest, a greater freedom in speaking, and engaged in activities that were more in keeping with objectives of the study of literature. These statements are all in favor of the extensive method, but unfortunately they are based on subjective observations and conditions.

The experiment by Rhodes [18] was conducted with two classes from Grade VII having superior reading ability.

[18] *Ibid.*

Both classes were balanced in mental ability. One class was given systematic training in reading, consisting of diagnosis of individual difficulties, intensive study of words for expressing shades of meaning, making and interpretation of definitions, selection of groups of words expressing the central idea of a paragraph, and frequent measures of progress by means of McCall's Standard Test Lessons in Reading. In the second class, the pupils read any worth-while book. An effort was made to stimulate interest so that pupils would do home reading. The discussion in class was like a friendly conversation. When several pupils read the same book, they gathered in groups to discuss it. In connection with daily lessons, short stories were told, mythology was studied, and poetry was read and memorized. The improvement of each class was measured by means of the Stanford Achievement Test. The class which had intensive training gained an average of 15.4 points as against an average of 4 points by the class which read for appreciation. The experimenter concluded that wide reading by superior pupils is not sufficient. They also need some intensive training.

Both intensive and extensive methods have their place in the teaching of literature. When the objective is to develop technique in speed and comprehension, there is little question of the need for intensive training. But when the objective is to develop a wide knowledge of literature, to understand a selection as a whole, to see the relations of parts to the whole, and to get the entire story, then the extensive method seems the more appropriate. The extensive method, however, presupposes a fair degree of reading ability. If this condition is not found, then again the remedy is to be found in intensive training at the point of error. In most cases, the extensive method is more appropriate for the study of literature.

Literature is not a science; it does not give recipes for baking cakes or building cabinets and consequently does not need to be read with literal accuracy. An author's purpose is usually to tell a story or convey some other general impressions. Thus, wide and rapid reading seems most appropriate. Before an accurate choice can be made between extensive and intensive methods, we should find out what the interest order is in the qualities of a given selection. Is it the story? the characters? the conclusion? the choice of words? the figures of speech? the action? the philosophy, or what? After this is determined, then we can adapt the method to the purpose.

Summary

The major objectives of the study of literature are to learn to read it for enjoyment and entertainment, to appreciate its aesthetic values, to get a vicarious experience in all phases of life, and to increase the reader's information about words, authors, types of literature, nature, and life. Such objectives as the correct use of English, improved ability to think, and the development of moral character, may be aided by the study, but to make them major objectives is likely to prove disappointing.

The principle of organization as applied to the teaching of literature refers principally to three factors that increase the comprehension of the thought, although it may mean a number of other things, such as the formation of rhythmical, emotional, and intuitive patterns.

Some factors involved in literary appreciation appear to be comprehension, imaginative power, appeal to interest, practice, perception of rhythm and rhyme, knowledge of technical devices, wide experience, sympathetic attitudes, and recognition of personal relationship to the author. Scientific investigations do not enable us to

determine the relative importance of each of these. Most of the studies relate to comprehension, interest, and practice.

The ability to read is fundamental. There is great need for the improvement of this ability among high-school students. Some ways of improving reading ability are: developing a proper background in the reader, directing attention to the theme and to the important questions, directing him to interpret words according to the context, and developing a favorable mental set for a given selection. This may be done with the aids of advance questions over the content, advance explanations, motivated drills with directions requiring a response, exercises, problems, questions on relations between title and main thought, and supervised practice in which attention is given to the individual's needs.

Both intensive and extensive reading have their place in teaching literature. Intensive reading should be used for developing techniques in speed and comprehension, and extensive reading for developing wide knowledge, understanding selection as a whole, and seeing the relation of parts to whole.

Supplementary Reading

Griffiths, D. C., *Psychology of Literary Appreciation.* Melbourne, Australia: Melbourne University Press, 1932.

Parker, Roscoe E., *The Principles and Practice of Teaching English.* New York: Prentice-Hall, Inc., 1937.

Smith, Reed, *The Teaching of Literature in the High School.* New York: American Book Company, 1935.

CHAPTER 7

English Literature: Individual Differences

Achievement in English literature, as in other subjects, is closely related to age, sex, grade, intelligence, and other characteristics of personality. The influence of age and sex is shown in the choices that occur in voluntary readings.

Choices of Books in Relation to Age and Sex

Lists of voluntary readings show that most of them are some form of fiction. The investigations of Jordan,[1] and of Terman and Lima,[2] showed that over 90 percent of the material chosen was fiction or imaginative composition of some kind, but according to Monto, fiction accounted for 75 percent of the voluntary reading. If we include poetry, the amount of imaginative composition is about 79 percent. The smaller amount found in her investigation was probably occasioned by the more advanced age of the pupils, who were limited to those in junior and senior high school, and about two thirds of whom, in fact, were senior high-school pupils. The three investigations agreed that informational material had only a small attraction for high-school or grade pupils.

According to Jordan, 58 percent, and according to Terman and Lima, 56 percent, of the fiction chosen by boys consisted of stories of adventure. Both investigations

[1] Jordan, Arthur M., *Children's Interests in Reading.* Chapel Hill: University of North Carolina Press, 1926.

[2] Terman, Lewis M., and Lima, Margaret, *Children's Reading.* New York: D. Appleton-Century Company, Inc., 1927.

agreed that only 18 percent of such material was chosen by girls. In regard to love stories, the situation was about reversed. According to Jordan, 42 percent of the books read by girls and 18 percent of the books read by boys consisted of adult fiction while, according to Terman and Lima, 16 percent of the reading of girls and 3.5 percent of the reading of boys consisted of emotional fiction or popular novels and love stories. Jordan determined that 35 percent of the reading of girls was juvenile fiction, while only 15 percent of the boys chose this kind. According to Terman and Lima, 32 percent of the reading of girls consisted of stories of home and school, but this material accounted for only 2.5 percent of the boys' reading. The classifications of Jordan, and of Terman and Lima, showed small sex differences in the choice of books on informational material, but this was not true in the choice of magazines. Those on science were read almost wholly by boys, while those on women's arts were read almost exclusively by girls. This difference in choice of books was also true when the sex differences were studied by titles rather than by a general classification of content. Another point that should be emphasized in regard to sex differences was the agreement found in Jordan's investigations, which were made eight years apart in time and in widely separated places. His important findings were also confirmed by those of Terman and Lima, although the average age of their readers was much less.

This constancy of human nature in regard to sex differences in the choice of reading material may be interpreted with reference to constancy in hereditary impulses, instincts, tendencies, or motives, or to constancy in the differences in training or environment of the two sexes. In spite of the fact that many psychologists no longer believe that human beings have instincts, it appears that

this concept furnishes the easiest explanation for sex differences in the choice of voluntary reading. Environment appears too varied to account for the choices made, but those who believe otherwise may explain how it is equal to the task.

Original nature accounts not only for sex differences in the interests of boys and girls in reading materials, but also for many of the changes that occur in the development of the high-school pupil from ages eleven to eighteen. Terman and Lima found that the earlier interests in jingles, nursery rhymes, and fairy tales wane a great deal at the age of eleven, when the boy has a great interest in adventure and mystery, and the girl has an equivalent interest in home, school, and animal life, as evidenced by her fondness for such works as *Little Women* and *Black Beauty*. At 12, their interests remain practically the same with an additional interest in hero-worship and biography. At 13, the girl reads many adult novels, such as *Little Shepherd of Kingdom Come* and *The Trail of the Lonesome Pine*. At 14, sentimental and emotional fiction become her dominant interest, and at 15, she adds nature stories of the type written by Gene Stratton Porter, as well as poetry and drama. The boy, at 13, intensifies his interest in adventure and hero-worship, but at 14 he develops an interest in science, mechanics, and other informational reading. The latter may become technical and highly specialized by the age of 15. At 16, boys and girls are thought to have practically the same interests as adults.

Jordan gave a similar but a little fuller picture of the development of the interests of boys and girls from ages 11 to 18. The boy from 11 to 13 is interested in sensory life for its own sake, as evidenced by the multiplicity of the experiences that the hero shares, the rapid and sud-

den changes of scene, and the vividness of detail necessary to attract him. He is interested in mastery and rivalry, admires outdoor sports, has a zest for war and fighting, and has a milder but real interest in kindliness and friendships. The satisfiers that appear in his books are physical strengths, independence, self-control, "making" a team at the expense of an unjust rival, saving a person's life, gaining mastery in physical combat when the opponent is despicable, being loyal, going somewhere, having new experiences of almost any kind, gaining the plaudits of one's fellows, being honest, and winning admiration in these things.

From 11 to 13 the girl shows interest in maternal rather than in fighting qualities. She expresses the instinct to nurse, to care for and fuss over others, to relieve, comfort, and console. She is not so much interested in rapid action as in time to sit and dream, but she likes to take a trip to the city where gay people in handsome clothes attract her. She is sensitive to the opinions and attitudes that others show toward her clothes; her heroine is usually shy and expresses her rivalry in being unselfish, kindly, and thoughtful. The chief satisfiers for girls are the reading about kindliness to others, wearing beautiful clothes, holding a high social position, being honorable and unselfish, being useful in the home, playing pranks at school, being honest at school, gaining the esteem of those worth while at school, being loved and admired for oneself, protecting the weaker, having things happen, being open and not deceitful, getting a box from home and having a feast, being successful in dramatics, and going to the city if a country girl. After 13 the sex impulse begins to show itself in the increasing amount of adult fiction chosen by both boys and girls, although in girls this interest is evident as early as the eleventh year. The im-

pulses of mastery, rivalry, and fighting continue to be strong in boys throughout high school, but in girls the sex impulse, together with maternal and kindly impulses, seems to influence the choice of all but 15 percent of the books that are very much liked.

Changes in Relation to Grade

The relation of grade to achievement in knowledge of literature may be seen in the grade norms of any of the standardized tests in this field, such as the *Barret-Ryam Literature Test,*[3] the *Columbia Research Bureau English Test,*[4] the *English Literature Test* by Omwake, Schwarz, and Rouning,[5] the *Stanford English Literature Test,*[6] and the *Stanford Tests of Comprehension of Literature.*[7] For convenience we take the norms of the test by Omwake, Schwarz, and Rouning. This test contains 160 elements. Most of them are on American and English literature, although there are a few items on the literature of other nations. In this test the median achievement for high-school freshmen is 30; for sophomores, 38; for juniors, 48; for seniors, 78; and for college students, 98. Other tests of literature information show similar relative differences. In ability to judge and appreciate poetry there is a similar development in relationship to advancement through the grades. This is shown in the scores obtained by the Abbott-Trabue *Exercises in Judging Poetry*[8] and by the Logasa-Wright *Test for the Appreciation of Liter-*

Published by:
[3] Bureau of Educational Measurements, Emporia, Kansas.
[4] World Book Co., Yonkers-on-Hudson, New York.
[5] Center for Psychological Service, 2024 G. St. N. W., Washington, D. C.
[6] Stanford University Press, Stanford University, Calif.
[7] *Ibid.*
[8] Bureau of Publications, Teachers College, Columbia University, New York.

ature.[9] The Abbott-Trabue test consists of thirteen sets, each of which has four versions of a poem. One of these is the original, while the others have some falsification or modification of the feeling, imagery, meter or other aspect of the original poem. Most of the originals are selected from standard English poets such as Scott, Tennyson, Shakespeare, Browning, Keats, and Burns. The pupil's task is to select the best poem from each set. The highest possible score is therefore 13, one point for each set. The grade norms for this test increased from 4.0 for students of Grade VII to 6.0 for high-school seniors. College seniors make an average score of 8.0, while graduate students in English attain an average of 9.5.

The *Tests for the Appreciation of Literature* by Logasa and Wright consist of six tests. Test I is comprised of ten selections of poetry for each of which the pupil must find one word describing the theme. Test II consists of twelve selections for which pupils must indicate the emotions aroused. Test III contains selections for which the type of imagery suggested is to be indicated. Test IV contains ten poetic comparisons which the pupil must mark as true, farfetched, or mixed. Test V contains expressions which are to be marked as fresh or trite, while Test VI contains ten poetic selections the rhythm of which is to be indicated by marking a diagram supposed to be its visual counterpart. There are norms for each year of high school and college. Each of these shows a gradual increase from the first year of high school to the last year of college. The amount of their growth is indicated by the total scores, which are 29 for the first year of high school, 35 for the last year of high school, and 43 for the last year of college.

[9] Public School Publishing Co., Bloomington, Ill.

Sex Differences in Achievement

That girls are somewhat superior to boys in knowledge of literature and language is shown in several tests which the writer gave to 110 freshmen boys and 113 freshmen girls entering Fort Hays Kansas State College in September 1932. One test was the literature part of the Entrance and Classification Examination for Teachers Colleges, 1932; the other was Part I, Language and Literature, of the Sones-Harry Test of High-School Achievement. In the first test, the median for the boys in terms of the McCall *T* score was 49.55, as against 52.56 for the girls; the percent of boys exceeding the median girl was 36, and the chances in 100 that the difference is greater than zero were 64. In the second test, the median for the boys was 47.78, as against 51.63 for the girls; the percent of boys exceeding the median girl was 32, and the chances in 100 that the difference is greater than zero were 64. Interesting sex differences in the appreciation of literature are shown by Carroll[10] in the results obtained from the *Carroll Prose-Appreciation Test.* He gave this test to 1,200 high-school pupils—600 girls and 600 boys selected at random from junior and senior high schools. The results showed that the boys and girls were about equally variable in their respective abilities to appreciate prose, that the girls were more than twice as likely as boys to be found in the highest decile, and that the girls were markedly superior. Only about one third of the boys equaled or exceeded the median score for girls. Although girls are superior to boys, the differences are not large enough to be noticed in an educational sense.

[10] Carroll, Herbert A., "Influence of the Sex Factor Shown in the Appreciation of Literature," *School and Society,* Vol. XXXVII (1933), pp. 468–72.

Relation of Ability in Literature to Ability in Other Tests

The relation of ability in other tests was shown in the correlations obtained by the writer in the test given by him, as described in the foregoing paragraph. The results showed that achievement is positively related to that in other subjects but not in equal degrees. The correlation with each other of three English Tests, the Teachers' College Literature Test, Cross English, and Sones-Harry Language and Literature, ranged from .48 to .73. Those between literature and social science, history, and geography ranged from .46 to .59, and those between literature and natural science, arithmetic, and nature study ranged from .07 to .39. While it would be possible to calculate a regression equation of achievement in literature on the other tests, it would not be worth much, as the best indices of success in literature are success in some other English course and in social science.

Word knowledge. The relation of word knowledge to the appreciation of literature was investigated by Garrison and Thomas.[11] Literary appreciation was measured by means of Tests I, II, and III of the Logasa-Wright tests. Word knowledge was measured by three tests of vocabulary, namely: (1) given the key word, to find other words that rhyme with it, (2) given the letters *a-, e-, o-, b-, m-, t-,* to build as many words as possible from them, and (3) a test of vocabulary designed after the Holley Sentence-Vocabulary Test. The performance in each of these tests was correlated with the performance in each of the tests of literary appreciation. The tests of literary appreciation were also correlated with each

[11] Garrison, K. C., and Thomas, Mabel, "A Study of Some Literature-Appreciation Abilities as They Relate to Certain Vocabulary Abilities," *Journal of Educational Research,* XXI (1930), pp. 316–399.

other. The results showed that the word-building test had little relation to the tests of literary appreciation, the correlations varying from .07 to .12. The rhyming tests correlated .12 with discovery of themes, .26 with indication of emotions or reader participation, and .45 with sensory images. The sentence-vocabulary test correlated .30 with discovery of themes, .44 with indication of emotions, and .56 with sensory images. The correlations between the tests of literary appreciation varied from .26 to .30. According to these results, knowledge of vocabulary has a positive but moderate relation to literary appreciation, and the latter appears to be a composite of a number of abilities which are only slightly related to each other. The Logasa-Wright tests consist largely of poetic elements and probably measure only a limited number of factors entering into literary appreciation. After we have more complete tests of this kind and many more experiments showing the relation of various factors to literary appreciation, we shall be able to say something more helpful about developing literary appreciation.

The foregoing paragraph shows the relation of average achievement in literature to the average amount of ability in other traits. However, a more significant fact about individual differences is the wide variation of the individuals within each group according to age, grade, and sex. These variations are not characteristically different from those in English composition shown in Table 3 (page 104). For example, the difference between the medians of the juniors and seniors was only 8 points, while that between the highest and lowest junior was 125. It is, therefore, not necessary to show again distribution of individual scores. It is more important to discuss ways of adjusting instruction to these differences.

Methods of Adjusting the Instruction in English to Individual Differences

The principal methods of adjusting instruction in literature to individual differences are those used in connection with the free reading period and with ability grouping. The important adjustment to be made is to see that a pupil has selections that meet his own interests, ability, and needs. The free period provides an opportunity for using such selections. To make such an arrangement successful, it is necessary that the teacher know the background of each pupil, his tastes, and numerous selections that may be used for satisfying these tastes. After these conditions are met, the principal requirement is to give individual help and to devise means by which the pupil may receive credit for his accomplishments.

Homogeneous grouping. Homogeneous groups in literature have been found particularly helpful for the inferior and the superior groups; in the first case because the instruction could be devoted to the development of fundamental reading habits, and in the second case because the instruction could be devoted to a wide study of masterpieces of literature. The results of the idea of selecting a superior group to see what can be done with it are shown in an experiment made by La Brant [12] in the Mt. Oread Training School of the University of Kansas. She administered the Thorndike-McCall reading test, the Holley vocabulary test, and a group-intelligence test to pupils in Grades X, XI and XII. Those who had a mental age of 18 years who passed the norm for Grade XII in these tests, and who were approved by the teacher as having well-developed reading habits as well as good abil-

[12] La Brant, Lou L., "Certain Criteria for Classifying Pupils in Literature Courses," *School Review*, Vol. XXXV (1927), pp. 458–466.

ity to interpret literature, were selected for the class. Only 8 pupils out of 60 met these requirements. The pupils spent three weeks on mythology and then turned to Greek plays. Finding that not all literature was English, they read translations of French, Italian, and Spanish novels, plays, and stories for a period of eight weeks. The last four weeks were spent on English literature during which Ruskin's *Sesame and Lilies* and Shakespeare's *Hamlet* were studied. During the course no attempt was made to teach history of literature, although authors were placed in point of time and general background. Lists of books were supplied; the pupils were allowed to choose, and no two read the same materials. The amount of outside reading done is illustrated by the readings of a fifteen-year-old girl, who ranked C, or average, in this class of eight pupils, who were very select, as explained above.

Her list was as follows:

Guerber, Myths of Greece and Rome
Lang, Tales of Troy and Greece
Leland, The Gypsies
Aristophanes, The Frogs
Euripides, Alcestis
Dante, The Inferno (3 cantos)
Calderon, Life in a Dream
Cervantes, Don Quixote (in part)
About, King of the Mountains
Hugo, Les Miserables
Ibsen, Pillars of Society
De Maupassant, Short stories (30)
Maeterlinck, The Blue Bird
Barrie, A Kiss for Cinderella
Sheridan, The Rivals
Conrad, Lord Jim
Dickens, Old Curiosity Shop
Hawthorne, The Scarlet Letter
Kipling, The Light that Failed
Stevenson, Strange Case of Dr. Jekyll and Mr. Hyde.

Summary

Choices and achievement in literature are closely related to the characteristics of the individual. This is particularly noticeable in the choices made in voluntary readings. Both sex and age make a difference. Boys prefer stories of adventure and fighting, while girls prefer stories of love and home. With respect to age, a boy's interest changes from fairy tales, through adventure, fighting, mystery, and sports, to science and mechanics. The girl's interest changes from fairy tales, through tenderness, home, and clothes, to love and society.

Knowledge and appreciation of literature increase with the student's advancement through the grades.

Women are somewhat superior to men in their learning achievement in literature. The difference, however, is not large enough to be noticed in an educational sense.

Achievement in literature is positively correlated with achievement in other subjects, but in unequal degrees. It is highest with language, next highest with social studies, third highest with natural science, and lowest with nature study. The best indications of success in literature are success in language and in the social studies.

Achievement in the appreciation of literature has a fair amount of correlation with knowledge of vocabulary. It, however, seems to be a composite of many factors, which appear to be only slightly related.

Possibly the most acceptable method of meeting individual differences is to make use of the free reading period as an opportunity for giving each pupil the selections which meet his interests, abilities, and needs.

Homogeneous groupings in literature make it possible to satisfy the needs and interest of both the inferior and the superior; for the inferior because it makes possible the development of fundamental reading habits, and for

the superior because it makes it possible for them to read the kind of literature that challenges their powers.

Supplementary Reading

Carroll, H. A., "Influence of the Sex Factor Upon Appreciation of Literature," *School and Society*, Vol. XXXVII (1933), pp. 468–472.

Center, Stella S., "A Federal Project in Silent Reading," *English Journal*, Vol. XXVI (1932), pp. 22–31.

Center, Stella S., and Persons, Gladys L., *Teaching High-School Students to Read*. New York: D. Appleton-Century Company, Inc., 1936.

Fritz, Ralph A., and Rankin, Nellie A., "The English Handicap of Junior High-School Pupils from Foreign Speaking Homes, and Remedial Suggestions," *Journal of Educational Research*, Vol. XXVII (1934), pp. 412–421.

Garrison, S. C., and Garrison, K. C., *Fundamentals of Psychology in Secondary Education*. New York: Prentice-Hall, Inc., 1936.

Taylor, Earl A., *Controlled Reading*. Chicago: Univ. of Chicago Press, 1937.

Wilty, Paul A., and Kopel, David, "Remedial Reading in High School," *English Journal*, Vol. XXV (1936), pp. 533–543.

CHAPTER 8

English Literature: Motivation and Materials

Stimulating Interest in Reading Literature

Although no controlled experiments have been made of methods of creating an interest in reading literature, teachers have worked at this objective and have used many methods, such as requiring book lists and book reports, forming book clubs, developing reading habits, using current literature, reading and acting dramas, emphasizing oral reading, and many others. Lyman[1] reported an investigation by Witter, who reported and recommended the following procedures:

"(1) Post short lists or books suitable for outside reading; change lists at frequent intervals to attract attention; give a brief synopsis under each title. (2) Give instruction in the use of the library. (3) Advertise good books by means of posters and blackboard announcements. (4) Discuss with the pupils the whole matter of reading and explain the nature of the different books from which they will read. (5) Include only a few authors in each book list, with several books written by each; impress on the pupils that opinions about an author are worthless unless several works have been read. (6) Encourage the pupils to suggest reading materials, in order to develop the idea that reading is a pleasure. (7) Give credit for outside reading. (8) Read material

[1] Lyman, R. L., *The Enrichment of the English Curriculum.* Chicago: Univ. of Chicago Press, 1932.

in class which will suggest reading of similar material outside. (9) Have pupils keep records of the books they have read and exchange the records for comparison. (10) Read a book with and to a pupil until sufficient interest has been aroused to lead the pupil to finish the book himself. (11) Stimulate reading by monthly book chats and individual conferences with pupils. (12) Assign topics which require reference reading; have each pupil keep a bibliography of material read and be able to report in writing on any book in the bibliography. (13) Section the class and have each section read a different book and attempt through reports to interest the other sections in the book read. (14) Have the class spend one hour each week in recreational reading in the school or public library; books to be read may be placed on reserve shelves so that the pupils may begin their reading without loss of time."

We shall now discuss some of these procedures.

Book lists and reports. Stimulating the reader's interest can do much to increase the amount of reading. The most common method is the book list, but its effectiveness depends on how it is made and used. Lists of the most popular books should be helpful if placed in the hands of pupils or posted so that they can be easily read. One objection to such lists is that they lack the personal touch. A list prepared by the teacher of books he himself has read and knows to be profitable and enjoyable is more effective. The interest in this list can be further increased by the teacher's comments on some interesting features in each book. In Newark, the high-school teachers have prepared a thirty-page pamphlet in which are listed the titles of books which they found interesting when they were young. Each year about a hundred titles are marked for reading. The student has an opportunity

to handle these books and discover his own tastes in reading. Such a list has the advantage of being recommended by persons whose judgment is usually respected. In a similar manner, a cumulative list may be prepared by the pupils themselves. Such a list would become quite complete in a few years and would have the advantage of presenting books enjoyed by readers of like ages and tastes.

The book list is only the starting point for creating an interest in reading. Unless the reader can tell some one how he enjoyed the book and get some recognition for it by his school and friends it is of little avail. A book report of some kind will meet this requirement. Teacher *A* reported an interesting plan for book reports. He had regular class periods for this purpose. Two weeks before the reports were due the student handed in a signed card, which gave the title and author of the book for his report. He also prepared a poster or advertisement for the book-review day; the class appointed a librarian and each student called for his card. In his report the student assumed the role of the author and told about his life, told the story of the book briefly, and displayed his poster. He had from 7 to 12 minutes for this report. Often the report took the form of a dramatization of interesting scenes and the reading of correspondence between the reader and the author. Teacher *B* reported a more simple method which he had found to be successful. He required his students to select one book a month for a report. The report included four headings on a card prepared for the purpose, namely: "Name of Author," "Title of Book," "Date," and "Remarks." The pupil filled in spaces for as many books as he had read. The remarks were purely informal and personal. In addition to this procedure, Teacher *B* had one class period a month

for a book chat in which he told of his personal experiences in reading and answered any questions that his pupils cared to ask.

The Book Club. Another method of giving recognition to students for reading books is to organize a book club in which the activities may be book reports, plays based on books, debates on best books, pageants of book characters, recitations of stories in books, and talks on books by teachers, authors, and others interested in books. Most of these activities are also suitable for assembly programs, which will be valuable in furnishing not only interesting entertainment but also good advertising for interesting books.

Developing habits of reading as a method of satisfying special interests. Possibly the best psychological way of creating a permanent interest in reading is to develop habits of reading books as a means of satisfying an interest in certain lines of subject matter. H. C. Hill reported a method of attack which he found to be successful in his course on community life problems and which was divided into four parts: (1) group life, (2) problems of the community, (3) industrial society, and (4) government and politics. In studying each of these topics the pupils were furnished with an extensive bibliography composed of references illustrating the topic in question. The titles were grouped into: (1) study references, (2) history, biography, travel, and essay, and (3) imaginative literature. The outside reading was checked by having the pupil report on a card the title of his book or article, how it related to the topic, and what he liked or disliked about it; by devoting an occasional class period to an informal conversation on the readings, and by having each of the pupils give a two- to five-minute talk on his readings. After four years of trial of this method,

Hill reported that it had demonstrated its utility by helping to make the use of good English habitual instead of spasmodic, by promoting an interest in reading, and by creating an interest in books that abided long after the completion of the course.

Using current literature. Some teachers have found that the secret of creating and maintaining an interest in literature is to approach it through the study of current magazines, newspapers, and novels. The gap between *Main Street* and *Ivanhoe,* or between the poetry of Edgar Guest and Milton's *Paradise Lost* is so wide that interest in these old classics is very difficult to create. The pupil of today has little background for *Ivanhoe,* but as he lives on Main Street, the teacher does not need to spend hours supplying background, but can give his time to the story.

Current literature is especially valuable in acting as a stepping stone for introducing the pupil to the classics and serving to interest the pupil in types of reading which he will continue to use after graduation from school. From the short story it is an easy step to the serial, and from the latter it is an easy transition to the historical development of the novel. Abbott [2] has found the study of current magazines to be a particularly favorable approach to the essay, which many teachers find to be a stumbling block for interest. Macaulay's essay on *Warren Hastings* and the papers in the *Spectator* usually provoke no great excitement among high-school pupils, whereas it is easy to interest them in current articles on prohibition or disarmament. From these, Abbott found that an interest might grow in the historical development of the essay. In a similar manner, simple modern poetry has been found useful as an introduction to *The Lady of*

[2] Abbott, Allan, "A High School Course in Periodical Literature," *English Journal,* Vol. II (1913), pp. 422–427; "A High School Course in Drama," *English Journal,* Vol. II (1913), pp. 93–98.

the Lake; modern British poetry as an introduction to Milton's minor poems; Coffman's *Modern Plays* as an introduction to *The Merchant of Venice; Emperor Jones* as an introduction to *Macbeth;* Hyde's *Modern Biography* as an introduction to the *Life of Samuel Johnson;* Pyle's *Men of Iron* as an introduction to *Ivanhoe;* Gras's *Reds of the Midi* as an introduction to *The Tale of Two Cities;* Walpole's *Fortitude* as an introduction to *David Copperfield;* and Haliburton's *Glorious Adventure* as an introduction to the *Odyssey.*[8]

Reading and acting dramas. Many believe that the study of drama offers the best opportunity for the all-around training of the pupil. Drama expresses the social thought and ethical standards of the day. It provides an opportunity for expression and training in speaking, for the development of a social disposition, for a share in the common experiences of people, for the comprehension of the underlying principle of art—the effort of the mind to express its total reactions to life—and for the acquisition of the technique of drama and the principles of expression. Its study should also develop the ability to judge and enjoy the best in drama and so develop the taste of the public for wholesome dramatic entertainment. Besides, it has the pedagogical advantage of appealing to a strong inherent nature in high-school pupils—the desire for action.

In the study of drama teachers have found that certain methods should be avoided and others emphasized. There is much opposition to preaching and moralizing,

[8] Cook, Thomas R., "Approaching the Classic Through Modern Literature," *English Journal,* Vol. XXIII (1934), pp. 472–474; LeMay, Elizabeth, "Reading for Enjoyment," *English Journal,* Vol. XXIV (1935), pp. 728–735.

minute study of metrics and form, investigations of the purpose of every act and scene, inquiries into the author's philosophy of life, analytic study of figures of speech, analogues, and disputed questions about authorship and dates of writing and publication. On the other hand, there is much opinion in favor of emphasizing the dramatic value of a play, or the impression it makes on an audience, as contrasted to its value as literature; providing exercises in tableaux and dramatization, attending dramatic entertainments, correlating literature and public speaking, reading rapidly many plays, and emphasizing the relation of the author to his age. The most suitable starting point is usally found in modern drama because the student already understands the background and is interested in the story.

Use of voluntary readings. Probably the most effective way to create a permanent interest in literature is to select interesting content. If the content does not hold the reader's interest and attention, there is little possibility that he will enjoy it. Much assistance for finding suitable selections may be obtained from the results of numerous investigations of the voluntary readings of high-school pupils. These selections may not always be good from the standpoint of literary merit, but they are undoubtedly proper for giving the pupil a good start. Investigations of the voluntary readings of children of high-school age are valuable for any teacher of literature or librarian because they tell us what high-school students like to read.

Lists of the Most Popular Books

We give below the titles of some of the most popular books found in the investigations of Washburne and

Vogel,[4] Jordan,[5] Hughes,[6] Terman and Lima,[7] Monto,[8] Johnson,[9] and Center and Persons.[10] Of these the list by Washburne and Vogel was the product of the most extensive investigation. The list was the outcome of an attempt to do two things: first, to find out what books were read and enjoyed by children; second, to find the age and degree of reading ability necessary for the children's enjoyment of these books. The answer to the first question was found by obtaining ballots from 36,750 children from Grades III to X. The ballots called for the complete title of book, author's full name, publisher, child's name, age, grade, school, sex, and teacher; a checking of a statement expressing the child's interest, such as "one of the best books I ever read," "a good book, I like it," or "not so very interesting"; the child's opinion of the difficulty of the book, such as "too easy," "just about right," "a little hard," or "too hard"; and a statement written by the child of what he liked about the book and why. The answer to the second question was found by giving the children the Stanford Paragraph Reading Test, deriving the reading age and grade, and then calculating the median reading grade of those who said that they liked the book. The median grade was called that for which the book was best suited. In addition to the me-

[4] Washburne, Carleton, and Vogel, Mabel, *What Children Like to Read*. Chicago: Rand McNally & Company, 1926.

[5] Jordan, Arthur M., *Children's Interests in Reading*. Chapel Hill: University of North Carolina Press, 1926.

[6] Hughes, Frances Mary, "A Survey of the Reading Interests of the Pupils of the Madison, Wisconsin, High School," *Education*, Vol. XLIV (1924), pp. 437–448.

[7] Terman, L. M., and Lima, Margaret, *Children's Reading*. New York: D. Appleton-Century Company, Inc., 1927.

[8] Monto, Saima W., *An Analysis of the Reading Interests of Junior and Senior High-School Students*. Master's thesis, University of Chicago, 1928.

[9] Johnson, B. Lamar, "Reading Interests as Related to Sex and Grade in School," *School Review*, Vol. XL (1932), pp. 257–272.

[10] Center, Stella S., and Persons, Gladys L., "Reading of High-School Students," *English Journal*, Vol. XXV (1936), pp. 717–727.

dian reading grade of those liking a book, Washburne and Vogel also calculated the median age of the children, and the percent of pupils in the median grade and in the two adjacent grades liking the book. The list so found was submitted to a group of thirteen children's librarians, who passed on the literary merit of each book. If 75 percent or more of the librarians judged a book to be trashy and of no value, the book was excluded from the published list. All these facts increase the ease of selecting an interesting and desirable book.

The reading preferences of children were also discovered by other investigators by means of ballots and questionnaires. Terman and Lima investigated the reading interests of 1,827 school children from Grades I to VIII. Jordan's investigation of 1925 included returns from 1,559 pupils from high schools of Greensboro and Charlotte, North Carolina, and his investigation of 1917 included returns from 3,598 pupils from Fayetteville and Stuttgart, Arkansas; Lawrence, Kansas; and Washington, D. C. Hughes's investigation was made of 1,500 pupils from the high schools of Madison, Wisconsin. Monto's investigation was made of 1,275 pupils from the high schools of Grand Rapids, Michigan, and Johnson investigated the reading interests of 1,856 children from Grades V to XI from schools of Duluth, Minnesota. Those selections common to three or more lists are given below. These are typical of the results found in all the investigations.

Call of the Wild
Tom Sawyer
Treasure Island
Huckleberry Finn
Penrod
Sea Wolf
Seventeen

Girl of the Limberlost
Little Women
Anne of Green Gables
Pollyanna
Rebecca of Sunnybrook Farm
Freckles
Little Men

Little Shepherd of Kingdom Come
Heidi
Sea Hawk
David Copperfield
Tarzan series
Ben Hur
Three Musketeers
Virginian
White Fang
Anne of Avonlea
Kidnapped
Dandelion Cottage
Uncle Tom's Cabin
Ramona

That the above titles represent something more than temporary and local interests in reading by high-school students is indicated in a study by Center and Persons of the reading interests of high-school students made ten years later than the studies represented in the above list. The ten most popular books for 46,972 New York high-school students were the following:

1. Call of the Wild
2. Tom Sawyer
3. Alice Adams
4. David Copperfield
5. Seventeen
6. Three Musketeers
7. Count of Monte Cristo
8. Huckleberry Finn
9. The Good Earth
10. Adventures of Sherlock Holmes.

The Most Popular Magazines

The interests of students in reading current magazines were investigated by Jordan,[11] Severance,[12] Engleman,[13] Kinder,[14] Huber and Chappelear,[15] Center and Persons,[16] and others. Jordan used the same sources for magazines

[11] *Op. cit.*
[12] Severance, H. O., "Magazines which High-School Pupils Read," *School Review*, Vol. XXXIV (1926), pp. 587–590.
[13] Engleman, J. O., "Outside Reading," *English Journal*, Vol. VI (1917), pp. 20–27.
[14] Kinder, R. L., *The Enrichment of the Curriculum.* Chicago: Univ. of Chicago Press, 1932.
[15] Huber, Merian B., and Chappelear, Claude S., "Children's Magazine Reading," *Journal of Educational Method*, Vol. VI (1926–27), pp. 145–149.
[16] *Loc. cit.*

as for books. Engleman secured results from 800 students in the high schools of Decatur, Illinois, in 1917; Severance from 378 students in the high schools of Columbia, Missouri, in 1926; Kinder from 801 students in the high schools of Pittsburgh, Pa., in 1928; and Huber and Chappelear from 659 pupils in two grade schools of Jersey City, New Jersey, 1926. Of the investigations, the one made by Jordan was the most thorough and extensive. Its order to obtain a picture of age and sex differences in preferences for magazines, and also a list of the most popular magazines according to the six above-named investigations, the writer scored each magazine according to the formula 100 $(R-.5)/N$ where R is the rank of popularity of the magazine in the investigation in question and N the total number of magazines reported in the investigation. The values were then converted into scores according to Table XIII, page 113, in Garrett's *Statistics for Students of Psychology and Education*. The advantage of this formula is that it makes the score of a magazine in one group (age, sex, investigation) comparable with that of another group and also makes it possible to obtain a total composite score which represents the value of a magazine when its rank in all investigations is considered. Because age and sex differences are best shown in Jordan's investigation some details of his results may be noted. Certain magazines appealed almost equally to either sex. These included the *American, Cosmopolitan, Literary Digest, National Geographic, Saturday Evening Post,* and *Youth's Companion*. Some appealed almost exclusively to one sex only. For example, *The American Boy, Boy's Life, Boy Scout, Collier's, Country Gentleman, Independent, Popular Mechanics, Popular Science, Review of Reviews, Science and Invention,* and *Scientific American* were popular only with boys; while *Delineator,*

Good Housekeeping, Mentor, McCall's, Photoplay, Red Book, Saint Nicholas, Woman's Home Companion, and *Woman's World* appealed only to girls. In relation to age, from 12–18, it may be noted that some increased in popularity while others decreased, and some began to be popular only at the upper limit of these ages. Those that increased in popularity within these limits were the *American, Cosmopolitan, Literary Digest, National Geographic, Popular Mechanics, Boy Scout,* and *Saturday Evening Post.* Those that decreased in popularity were the *American Boy, Boy's Life, Delineator, Ladies Home Journal, Pictorial Review, Popular Science, Red Book, Saint Nicholas, Woman's Home Companion, Woman's World,* and *Youth's Companion.* Those that began their popularity only at the upper ages were *Good Housekeeping, Mentor,* and *Science and Invention.*

TABLE 4

RANK ORDER OF POPULARITY OF MAGAZINES IN SIX INVESTIGATIONS

Magazine	Rank
American Magazine	1
Saturday Evening Post	2
American Boy	3
Popular Mechanics	4
Ladies Home Journal	5
Pictorial Review	6
Cosmopolitan	7.5
Literary Digest	7.5
McCall's	9.5
Woman's Home Companion	9.5
Popular Science	11
Delineator	12
National Geographic	13
Western Short Stories	14
Boy's Life	15
College Humor	16
Judge	17
Youth's Companion	18

Table 4 gives the composite scores of the magazines that appeared in three or more of six investigations. If we had restricted the list to those that appeared in four or more investigations we would have excluded *Popular Mechanics, McCall's, Popular Science, Delineator, College Humor, Woman's Home Companion,* and *Youth's Companion,* and there would thus remain only the *American Magazine, Saturday Evening Post, Ladies Home Journal, Pictorial Review, Cosmopolitan, Literary Digest, National Geographic, Western Short Stories,* and *Judge.*

That time and place make considerable changes in the popularity of magazines is indicated in Johnson's study of the reading interests of high-school students of Duluth, and Center and Person's study of the reading interests of the high-school students of New York. In Johnson's study, *Liberty* ranked first; *Collier's,* sixth; and *Good Housekeeping,* seventh. *The American Boy, Popular Mechanics, Cosmopolitan, McCall's, Delineator, National Geographic, Popular Science, College Humor, Boy's Life,* and *Youth's Companion* did not appear at all among the first ten. In the study by Center and Persons the most popular magazines were the following:

Hamilton (boys)	*Bay Ridge (girls)*
Popular Science	Saturday Evening Post
Popular Mechanics	Good Housekeeping
Readers Digest	Ladies Home Journal
Saturday Evening Post	Woman's Home Companion
Literary Digest	Collier's
Liberty	Cosmopolitan
Sports Magazine	Liberty
Detective Stories	Readers Digest
Boy's Life	Movie Magazine
Collier's	McCall's

Preferences in required readings. Just as there are preferences among books for voluntary reading, so there are preferences among them for required reading. Stud-

ies of such preferences have been made by McConn,[17] Crow,[18] and Uhl.[19] Studies have also been made by Conrad and Hickok,[20] and by Smith,[21] of the frequency with which the various classics were offered in the schools by the National Council of Teachers of English. The most striking fact about these studies is the divergence in rank of interest as shown by the reactions of students, and the rank in the frequency of offering. Comparisons may be made between McConn's study of the rank order in interest and the rank order in offerings, as shown by the study of the National Council of Teachers of English made in 1912 and in 1913, respectively. Similarly, we may compare the rank order in interest according to Crow's study in 1924 with the rank order in offerings shown in the studies made by Conrad in 1930 and by Smith in 1932. According to the first two studies, *Tale of Two Cities* ranked first in interest and thirteenth in offering. *The Last of the Mohicans* ranked second in interest and not at all in the thirty-five most frequently offered classics. *Ivanhoe* ranked third in interest and fifth in offering. *Hamlet* ranked fourth in interest and twenty-fifth in offering. *Enoch Arden* ranked fifth in interest and not at all in the first thirty-five offerings. *Silas Marner* ranked sixth in interest and second in offering. *Macbeth* ranked seventh in interest and first in offering. *The Lady of the Lake* ranked eighth in interest and fifteenth in offering.

[17] McConn, Charles M., "High-School Students' Ranking of English Classics," *English Journal,* Vol. I (1912), pp. 237–272.

[18] Crow, Charles S., "Evaluation of English Literature in High School," *Contributions to Education,* No. 141. New York: Teachers College, Columbia University, 1924.

[19] Uhl, Willis L., "The Derivation of Standards for Judging Reading Material," *Educational Review,* Vol. LXVI (1923), pp. 147–151.

[20] Conrad, Edna B., and Hickok, Katherine, "Placement of Literary Selections," *English Journal,* Vol. XIX (1930), pp. 377–384.

[21] Smith, Dora V., *Instruction in English,* Bulletin 1932, No. 17. Washington, D. C., Office of Education.

In Conrad and Hickok's study forty classics were ranked in their order of frequency of offering as they appeared in forty-four selected courses of study. In Crow's study, seventy-four classics were ranked in order of interest according to pupils' reactions, with rank one the highest and rank seventy-four the lowest in interest value. In this pair of studies *Idylls of the King* ranked second in offering and forty-sixth in interest value. *The Courtship of Miles Standish* ranked third in offering and twenty-seventh in interest. *Julius Caesar* ranked fifth in offering but forty-second in interest. *Tale of Two Cities* ranked ninth in offering and twelfth in interest. *The Vision of Sir Launfal* ranked ninth in offering and fifty-third in interest.

If we use Smith's study as a basis of frequency of offering, we get such results as the following: *Julius Caesar* ranked second in offering and forty-second in interest. *Ivanhoe* ranked fourth in offering and fifteenth in interest. *The Vision of Sir Launfal* ranked tenth in offering and fifty-third in interest. *Silas Marner* ranked first in offering and thirteenth in interest. There are some cases when the two ranks come fairly close together, but these are exceptions.

Another striking fact is the absence of high-ranking voluntary readings in the offerings of the curricula. This points to the existence of a wide gap between the books that pupils like to read and the books which the teachers and curriculum makers think that they ought to like. How to bridge this gap is a pressing problem. Possibly the solution can be found in the concept of growth or development. High-school students are at one stage of development, and teachers are at another. Between these two there is probably a continuous and gradual growth. If so, the teacher's task is to begin with pupils as they are

and to lead them by gradual steps to where the teacher thinks they ought to be.

Another method of attack on the solution of this problem is to choose popular and classical selections that have the same desirable qualities. According to this procedure, we begin with popular selections having certain desirable qualities and follow them with classics that have the same qualities. What these desirable and undesirable qualities of selections are was investigated by Uhl,[22] and by Broening.[23] Uhl found that the favorites for class study were *Silas Marner*, *Ivanhoe*, *Tale of Two Cities*, *Hamlet*, and *Macbeth*. From 95 to 99 percent of the teachers reported these as successful. They are favored because they contain such qualities as rapid action, interesting characters, simplicity, humor, portrayal of home life, supernatural elements, courage, sacrifice, ideals, and moral values. Among the most unsuccessful were such selections as *Henry Esmond*, Burke's *Conciliation Speech*, Washington's *Farewell Address*, the essays on Milton and Burns, and *Sesame and Lilies*. The reasons for dislike were: "lack of action," "overburdened with facts," "background too difficult," "tedious," and "too mature in appeal." In Broening's study the order of desirable qualities in books in the judgment of pupils was plot, easy reading, pictures, size and kind of type, verbal magic, cover, and appearance of page. According to the judgment of teachers it was plot, size and kind of type, appearance of page, easy-reading pictures, verbal magic, cover, and difficulty of reading. If we can find popular selections that have desirable qualities in common with the classical ones, they might be useful for bridging the gap between them.

[22] *Loc. cit.*

[23] Broening, Angela, "Factors Influencing People's Reading of Library Books," *Elementary English Review*, Vol. II (1934), pp. 155–158.

Summary

Methods of stimulating interest in reading are based on experiences rather than on experiment. Some methods that have been found to be effective are to use book lists based upon the cumulative experiences of students and teachers, to hold class periods in which students give their personal reactions to books read, to organize book clubs in which recognition is given to students reading books, to develop habits of reading for satisfying special interests relating to courses of study, to emphasize the study of current literature and use it as a stepping stone to the reading of classics, and to read and stage dramas. Probably the most effective way to create a permanent interest in literature is to select interesting content. A number of careful investigations have been made of the books voluntarily read by students of high-school age. A good example is the one made by Washburne and Vogel. The titles found in such studies show us that students like to read fiction. Similar studies of the most popular magazines show the same fact, although *Popular Mechanics* and *Popular Science* rank in such a list.

Just as there are preferences in voluntary reading, so there are preferences in required reading. The most striking fact concerning preferences is that popular classics are offered much less frequently than unpopular ones. There is a wide gap between what students like to read and what teachers think they should read. One possible solution to the problem of bridging this gap lies in the concept of development, according to which teachers should begin where students are and lead them to where they ought to be. Another possible solution is to begin with popular selections that have the same desirable characteristics as the classics and then transfer to the classics.

Supplementary Reading

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Milam, Carl H. (Chairman), *Children's Reading*. New York: D. Appleton-Century Company, Inc., 1933.

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Peterson, Anna, "Leisure Reading of High-School Pupils," *Education*, Vol. LIV (1934), pp. 296–300.

Washburne, Carleton, Weedon, Vivian, and Wilinson, Mary, *The Right Book for the Right Child*. New York: John Day Co., Inc., 1933.

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CHAPTER 9

Foreign Language: Objectives and Transfer Values

Values. Learning a foreign language has the same values for us as learning our mother tongue—communication with others, the extension of experience, the acquirement of information, and enjoyment. Ability to read a foreign language extends our experience beyond the limits possible with our own language. Although foreign peoples have much in common with ourselves, they also have differences—they see life from a different angle; they have different values and a different literature, and they make discoveries in science. Many of their contributions to civilization and life will always remain hidden to one who does not know their language. Then, too, mastery of a foreign language gives us that intimate knowledge of a foreign people without which little progress can be made in the promotion of international good will or in the abolition of violence as a means of settling international disputes.

There are also economic values in the study of a foreign language. Anyone preparing to enter a profession will find valuable training in reading the contributions of foreign peoples to his field, and if he intends to become an expert in a profession, he finds a knowledge of foreign languages a valuable addition to his professional skill. If a youth is preparing to enter commerce with foreign peoples, there is no doubt of the direct commercial advantage of speaking the foreign language. The same is true of those intending to enter diplomatic serv-

ice or to spend part of their lives in traveling among foreign peoples. It, therefore, makes little difference from what point of view we try to estimate the value of the study of modern foreign languages—it unlocks a key to a bigger and more useful life, provided, of course, the language is learned. While there is no doubt that many of these values can be obtained by reading in translation, it is more difficult to keep up-to-date without knowing the language itself.

In addition to the social, cultural, and economic values of the study of foreign language, teachers claim for it a number of so-called disciplinary values. They say that it gives the learner a continuity of progress in the acquisition of a skill, training in precision, definiteness and accuracy in detail, constant opportunity for self-checking, daily practice in memorization, an opportunity to discover the value of concentration which the pupil can apply to any task, and improvement in his native speech.

The values of the study of ancient languages such as Latin and Greek are more limited, but to those who master them, they too extend experience, furnish information, and give enjoyment. They are particularly valuable for those who wish to specialize in historical research and who wish to trace the origin and development not only of modern languages, but also of modern literature, law, philosophy, and science.

The study of both ancient and modern languages contributes to the understanding and use of English. These we shall discuss as transfer values.

Objectives. From the standpoint of the learner the question is: What specific objectives should be set up in order to acquire the major values of the language? Foreign-language teachers are not agreed among themselves as to what these should be, some holding that

nothing less than a complete mastery should be the objective and others contending that the principal objective should be a reading knowledge of the foreign language. As a means of arriving at a valid list of objectives, committees of investigation drew up tentative lists of objectives, submitted them to teachers for evaluation, and then formulated lists of the ones that were most generally approved. The list for the study of modern languages is as follows: [1]

Immediate Objectives

Progressive development of the power to:
1. Read the foreign language
2. Understand the foreign language when spoken
3. Speak the language
4. Write the language

Ultimate Objectives

1. Ability to read the foreign language with ease and enjoyment
2. Ability to communicate orally with natives of the country whose language has been studied
3. Ability to communicate in writing with natives of the country whose language has been studied
4. Increased ability to pronounce and understand foreign words and phrases occurring in English
5. Increased ability in the accurate and intelligent use of English
6. Increased power to learn other languages
7. A more effective realization of the importance of habits of correct articulation and clear enunciation
8. Increased knowledge of the history and institutions of the foreign country and a better understanding of its contribution to modern civilization
9. Increased ability to understand ideals, standards, and traditions of foreign peoples and Americans of foreign birth
10. Development of literary and artistic appreciation
11. Development of a more adequate realization of the individual to society
12. A clearer understanding of the history and nature of language

[1] Coleman, Algernon, *The Teaching of Modern Foreign Languages in the United States*, a report prepared for the Modern Foreign Language Study. New York: The Macmillan Company, 1929.

13. Increased ability to discern relationships and make comparisons between subjects allied in form and content
14. Development of habits of sustained effort
15. The ability to make prompt and effective use of foreign discoveries and inventions
16. Development of social adaptability through increased personal contacts with natives of other countries

The list of objectives for the study of Latin is as follows: [2]

1. Increased ability to read and understand Latin
2. Increased understanding of those elements in English which are related to Latin, such as
    (a) Latin words, phrases, abbreviations, and quotations occurring in English
    (b) The exact meanings of English words derived from Latin
    (c) The spelling of English words of Latin origin
    (d) The principles of English grammar
    (e) The technical and semitechnical terms of Latin origin
3. Increased ability to read, speak, and write English
4. Increased ability to learn other foreign languages
5. Development of correct mental habits, such as
    (a) Sustained attention, order by procedure, perseverance, ideals of achievements and accuracy
    (b) Recognition of identical elements in different situations
    (c) Correct reflective thinking
6. Development of an historical background, such as knowledge of the life of the Romans, of allusions to Greek and Roman mythology, and of the personal characteristics of authors
7. Development of right attitudes toward social situations
8. Development of literary appreciation
9. Elementary knowledge of the simpler general principles of language
10. Improvement of the literary quality of the pupil's written English

Factors to Be Considered in the Evaluation of Objectives

A judgment of the extent to which these objectives are attainable may be found by investigating the use made

[2] Advisory Committee of the American Classical League, *The Classical Investigation.* Princeton: Princeton University Press, 1924.

of foreign language by those who have taken the courses as they are offered in the schools, the length of time that a foreign language is usually studied in the schools, the achievement of students of foreign language at the completion of their courses, the content of the materials studied, the qualifications of teachers of foreign language, the comparative achievement of foreign and nonforeign language students in the use of English, literary appreciation, social adaptability, citizenship, and other skills to which the study of a number of subjects may contribute.

Each of these possible lines of investigation has a contribution to make to our problem. If a man uses a skill that he has acquired in school, that in itself is very good proof not only that he has learned it well, but also that it is valuable to him. Since it requires a long time to become efficient in the use of such a skill as a foreign language, it is evident that the objectives attempted should be limited to those that are attainable within the limits of the time given to the study of the language. Measurement of the achievement of students at the end of their courses gives us probably the most accurate idea of the results actually accomplished by students of foreign language. An analysis of the content of the material studied is important because, if it contains little that relates directly to an objective that is claimed for the study of foreign language, not much need be expected in the realization of that objective. Likewise, an analysis of teachers' qualifications is important because it is useless to expect much success in realizing such objectives as the ability to speak and write a foreign language and knowledge of a foreign people, if teachers cannot speak or write the foreign language in question or if they know little about the character and civilization of the people whose language they attempt to teach. Finally, the al-

leged disciplinary values of the study of foreign language cannot be warranted unless it can be shown that students of foreign language acquire them to a greater degree than do students of other subjects.

O'Shea's Investigation of the Use of a Foreign Language by Graduates

In connection with the determination of objectives it is interesting to notice the results of O'Shea's[3] survey of the extent to which modern foreign languages are read by persons who studied them in high school or college or both. He sent a questionnaire to about 20,000 persons who graduated from high school or college in the years 1903, 1908, 1913, and 1918. Questions were asked regarding the number of years spent in studying each of the modern foreign languages taught in the schools; whether the respondent taught any of these languages; whether he had read any foreign language in the original since graduation, how many pages, and for what purpose; how much of any foreign language he had read in translation since graduation and for what purpose; and others regarding the value and need of modern foreign language. Replies only from those who had not taught a foreign language were considered. The results showed that the percentage of students who did not read a foreign language after graduation depended on the number of years spent in its study, as well as on which language was studied.

Those who had studied French read more new material after graduation than those who had studied German or Spanish. Of those who had studied French two years

[3] O'Shea, M. V., *The Reading of Modern Language* (an investigation of the uses made of modern foreign languages by high-school and college graduates). Washington, D. C.: Bureau of Education, Bulletin No. 16, 1927.

about one third of the pupils read something new after graduation, and that proportion was about doubled if they had studied it four years. These statements are also true for those who had studied German or Spanish except that the proportions reading something new were smaller, particularly for those who had studied the languages four years. In this case the percent reading nothing new was 67 and 50 for German and Spanish respectively, while for French it was only 37. The amount read varied all the way from a few pages to over a thousand. In the case of French, from 2 to 4 percent read less than 100 pages, from 6 to 11 percent read from 100 to 500 pages, from 5 to 9 percent read from 500 to 1,000 pages, from 4 to 14 percent read over 1,000 pages, and from 10 to 23 percent read an indefinite number. When we compare these results with the percent of Latin students who read some new Latin after graduation the results are greatly in favor of modern language. Of those who studied Latin in high school, only one fourth of one percent reported reading anything new. For French this percent was 31; for German it was 21, and for Spanish it was 15. If the purpose of language instruction is to teach the child a skill that he will use, we see that this objective is attained to a fair degree in case of a modern language, but is almost totally unrealized in Latin. It should be noted, however, that in the case of Latin the percentages were for the number reading new Latin during the year previous to the investigation, while for the modern languages they referred to the period between graduation and the investigation. This condition favored the results for modern languages considerably.

Another question is the purpose for which a foreign language is read. The interesting results here were that in the case of both French and German, one half of the

readers read for the purpose of enjoyment; one fourth read for business communication and occupational interests, and one fourth read for purposes of research and travel.

Another possible result of the study of foreign language is the development of an interest in reading foreign authors in English translation.

O'Shea's results showed that the number not reading foreign authors in translation decreased with an increase in the length of study and, in general terms, that from one fourth to one third of those who studied a modern foreign language in high school read foreign authors in translation after graduation.

The conclusion which O'Shea drew from all his findings was that the principal objective in teaching modern foreign language should be the ability of the pupils to read, and that technical construction, composition, and accuracy in pronunciation and speaking should be much less emphasized. O'Shea drew no conclusions about Latin. But if it is referred to as rarely as his results indicate, we can find little justification for its study from this point of view.

Enrollment Statistics in Foreign Languages

Enrollment statistics in foreign languages are valuable in connection with an investigation of objectives because they give us an idea of the length of time spent in study. According to Wheeler's[4] results published in 1928, there were 1,614,574 pupils enrolled in foreign-language courses in the secondary schools of the United States, and nearly half of them were in Latin. The significant fact was that two years was the maximum length of study of a modern

[4] Wheeler, Carleton A., *Enrollment in Foreign Languages in Secondary Schools and Colleges of the United States.* New York: The Macmillan Company, 1928.

foreign language for about 83 percent of the pupils. About two fifths or 43 percent quit at the end of the first year. Less than 16 percent of those who began continued the study as long as three years, and less than 3 percent pursued the study as long as four years. For Latin the percentages are about the same. The enrollment in Latin for the United States in 1923-24 showed that, if we call the enrollment for the first year 1,000, it will be 682 for the second year, 313 for the third year, and 140 for the fourth year. The educator's problem is thus to find worth-while objectives that can be accomplished in two years. It is useless to think of complete mastery, but if one important objective can be attained, that alone might justify the student's enrollment.

The Content of the Foreign Language Courses

To acquire a reading knowledge of a foreign language a certain number of pages must be covered, and to learn about the culture, civilization, and character of foreign peoples, certain kinds of reading matter must be studied. Coleman[5] reported an investigation of the number of pages prescribed by state departments for reading in secondary-school courses of study, and also an investigation of the number of pages assigned for reading according to the estimates of teachers. In the state courses of study the average number of pages prescribed for French was 115 for the first year, 300 for the second year, 450 for the third year, and 500 for the fourth year. In German and Spanish the number of pages for each of the first three years was from one fourth to one third less. According to teachers' estimates the median number of pages assigned in French is 96–100 for the first year, 195–200 for the second year, 270–275 plus 6–200 pages of

[5] *Op. cit.*

supplementary for the third year, and 300–323 plus 80–250 pages of supplementary reading for the fourth year. If we recall that, in going through the first eight grades of the American public schools, a pupil must read at least 7,000 pages to meet the minimum requirements of this amount of education in his native language, we can form some idea of the inadequacy of the number of pages studied in the attempt to master a foreign language.

In regard to the kind of content, Coleman stated that fiction predominates in all the languages at all stages; that about 50 percent of the second-year group of teachers report the reading of 75–80 pages of drama; that about 25 percent report 20–25 pages of newspaper material; and that a similar fraction report 70–75 pages of other types of prose, presumably historical and other informative material. In regard to the character of the informative materials, an investigation made by Miss Gilman [6] showed that the most frequent topic was geography, with history and marriage rites coming second and third respectively. Some topics such as art, business and professions, clothing and dress, education, food, law, politics, and government occurred rarely. Those that did occur were usually no more than mentioned, and required the reader to find from other sources whatever was needed.

These statements indicate that the character of the materials studied is such that the student of foreign language will acquire very little knowledge of the history and institutions of the foreign country, its ideals, standards, and traditions, the relation of the individual to society, or of the history and nature of language. In other words, the cultural objectives claimed for the study of

[6] Gilman, Gertrude M., *The Cultural Material in the French Curriculum of Illinois High Schools*, Chapter VII. Modern Language Studies. New York: The Macmillan Company, 1930.

foreign language are invalidated by the materials studied. A knowledge of this deficiency by teachers and authors of textbooks should, however, make a speedy correction possible. To accomplish all the objectives set forth for the study of Latin, or even one of them, we should expect the principal means to be the use of a rich and extensive content. But here we meet our first disappointment. The Advisory Committee[7] recommended the reading of 40 pages of Tuebner text, that is, 40 pages of about 300 words each during the first year, about 75 pages during the second year, about 60 pages during the third year, and about 100 pages during the fourth year—a minimum total of 275 pages during four years of high school. While we agree that one kind of reading matter may be more valuable than another, we question whether 275 pages of Latin are adequate to the task when our objectives are to develop skill in reading Latin, attain mastery in English, produce a cultured and disciplined mind, and a number of other desirable traits.

The Qualifications of Teachers of Modern Foreign Languages

The qualifications of teachers are important in relation to certain objectives, particularly those of teaching the ability to speak and the history, institutions, character, and customs of a foreign people, for either of which study and travel in the foreign country is essential. Previous investigation showed that out of 10,096 teachers in the public secondary schools, 68.8 percent had no study or travel in a foreign country, 9 percent had no study, 8 percent had three months or less of study and some travel, 5 percent had from four to eleven months study and some travel, and 7.5 percent had twelve or more months of

[7] *Op. cit.*

study and some travel.[8] It is reasonable to suppose that only the last group would acquire a fair skill in speaking the foreign language and a reasonable knowledge of the history, institutions, and customs of the foreign people. But even if we make the same supposition for the last two groups, that would mean that only 12.5 percent or one eighth had enough experience in the foreign country to qualify for speaking ability and for the cultural objectives. To this should be added that 35 percent of the 10,096 teachers of foreign language in public secondary schools had less than three years of teaching experience, although the average for the entire group was about 12 years. The average number of years of preparation for modern-language teaching was 4.6; 87.7 percent of the teachers have college degrees, and 83.07 percent are women. The preparation of teachers seems inadequate for the speaking and cultural objectives. That the members of the profession believe themselves unprepared for realizing the speaking objective is indicated by Coleman's questionnaire, which was sent to selected teachers and which inquired about their preferences in method. He found that a majority of 541 teachers stated that oral work was neglected for three reasons: over-large classes, too much ground to cover, and lack of speaking ability in teachers. If, in addition to these reasons, we consider the large number lacking residence in a foreign country, the large number having less than three years of teaching experience, and the lack of opportunity for pupils to speak the foreign language in any real situation, we have good reasons for believing that the doubt of teachers of being able to teach speaking ability is well founded.

[8] Purin, C. M., *The Training of Teachers of the Modern Foreign Languages*, a report made for the Modern Foreign Language Study. New York: The Macmillan Company, 1929.

Attainment in Relation to Length of Study

Attainment may be judged from the opinions of classroom teachers and from the scores made in objective tests of different phases of skill in modern foreign language. The committee on investigation of the Modern Foreign Language Study submitted the list of objectives described on pages 187–188 to a large number of teachers and asked them to check the ones that were attained by 50, 60, 70,, 80, 90, and 100 of their students after one, two, three, and four years of study. The highest percent in favor of any one objective was 17.5, representing the ability to communicate in writing with natives whose language had been studied. The lowest percent was 3, representing the ability to make prompt and effective use of foreign discoveries and inventions. The significant finding of these reports was that, on the average, less than one sixth of the teachers believed that 80 percent of their students attained any of the sixteen objectives in two years of study.

The experimental evidence on the attainment of objectives showed that the teachers did not overestimate the abilities of their pupils. Coleman[9] gave results obtained from objective tests in grammar, reading, and composition. An objective test containing fifty grammatical items in French showed that the median number correct after one, two, three, and four years of study was 11, 25, 36, and 40, respectively. These figures do not mean very much without an accurate knowledge of the items in the test, but Coleman interpreted them as follows:

> It seems to be an unavoidable conclusion from this exhibit that the lower 50 percent of our two-year modern language classes give but a poor account of themselves in grammar, and that the corre-

[9] *Op. cit.*

sponding portions of the more advanced classes do relatively little better. In other words, unless the items of the test are less valid for secondary schools than they appear to be, the level of performance by at least half our modern language secondary students at the various year-stages indicates that our teaching of grammar does not yield encouraging results in knowledge of grammar.

The attainment in reading was measured by paragraphs of graduated difficulty, each of which was followed by questions designed to test comprehension. A comparatively easy paragraph from the French test showed that the percent of correct answers varied from 9 at the end of one year to 45 at the end of three years of study. A similar paragraph from the German test showed that the percent of correct answers varied from 18 after one year to 61 after three years of study. For illustration, the German paragraph, with the questions accompanying it, is given below:

Als Napoleon mit Österreich über den Frieden von Tampo Formio unterhandelte, nahm er plötzlich eine grosse, kostbare Vase, die neben ihm auf dem Tisch stand, und warf sie dem erschrockenen Österreichischen Diplomaten, der betraut war, mit ihm zu unterhandeln, vor die Füsse. "Wenn Sie nicht nachgeben," rief er aus, "werde ich Ihre alte Monarchie zerschmettern wier diese Vase hier." Der Oestereichische Diplomat, der an die überraschenden Formen der neuen Diplomatie nicht gewöhnt war, beeilte sich, den für Napoleon nötigen Frieden zu schliessen.

Answer in English:

1. Zwischen welchen Ländern wurden die Friedensunterhandlungen geführt?
2. In welcher Stimmung (Laune) schien Napoleon zu sein, als er die Vase zerschmetterte?
3. Welches Land ist mit der alten Monarchie gemeint?
4. Was bewog den österreichischen Staatsmann nachzugeben?
5. Was war das Ergebnis des Napoleonischen Verfahréns?

To one who can read but does not teach these languages the above samples of attainment indicate that high-school students do not learn to read these lan-

guages. Coleman, who based his judgments upon wide samplings of attainment, stated that at least half of the high school students completing two years of the study of a modern language do not learn to read or write them well enough to make any use of them for purposes of their own and further that the two-year course as conducted did not justify us in claiming for it the validity of the objectives of reading, speaking, and writing for the lower half of the group, and that the case was none too clear for the attainment of these objectives by the lower half of the class in the third year.

Let us now turn to the consideration of achievement in high-school Latin and find out how well the students learn to read it.

That high-school pupils do not learn to read Latin is indicated by the following facts:

1. The amount of Latin studied in four years is too limited, consisting only of about 275 or 300 pages of 30 lines each.[10] When we realize that graduates from the eighth grade have read a minimum of about 7,000 pages of English with the result that they are only moderately educated and are far from having mastered English, we cannot expect much from reading 300 pages in a foreign language.

2. Pupils who had completed two years of Latin in the state of New York [11] could make an average mark of only 75 in translating a simple but previously unseen passage of eight lines from Caesar, notwithstanding that the new words were defined and that about 25 minutes of time was allowed for the task.

3. Records of the way individual pupils translate Latin show that they do not read it.

This last fact may be illustrated by the record of an individual case, that of Mary Elizabeth, aged 15, a high-school sophomore, who is at this writing in her fourth semester of Latin. Her grades in Latin to date have been as follows: Latin I, *A;* Latin II, *C;* Latin III, *A;* Latin IV, first six weeks, *B*. She was asked to translate the

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[10] Advisory Committee of the Americal Classical League, *The Classical Investigation*. Princeton: Princeton University Press, 1924.

[11] Arms, S. Dwight, Bogart, Elmer E., and Morrison, J. Cayce, *Results in Latin, First Two Years*. Albany: University of the State of New York Bulletin No. 773 (Jan. 1, 1923).

following lines from Book II of Caesar's *Commentaries on the Gallic Wars,* which were a part of her daily assignment:

"Cuius adventū spē inlātā mīlitibus ac redintegrato annuo, cum prō sē quisque in conspēctu imperātōris etiam in extrēmīs suīs rēbus operam nāvāre cuperet, paulum hostium impetus tardātus est."

She read as follows:

"Whose arrival hope (stopped to look up *inlātā*) having been brought unto the soldiers and courage having been revived, since he desired for himself (stops to look up *conspectū*) the presence of authorities even (stops to look up *nāvāre*) even to do his best in his extreme affairs he delayed the attack of the enemy for a little while." ("It doesn't make any sense," she said, and so tried again). "By his arrival hope having been inspired in the soldiers and their courage having been revived, since he desired to do his best for himself anything (stopped to look up *conspectū* again) in the presence (stopped to look up *imperātōris*) in the sight of the commander to do his best even in his extreme difficulties he delayed the attack of the enemy for a little while." (Q. "Are you through?" A. "I haven't got this clause yet," pointing to clause before the last.) "Since he desired for himself anyone, since anyone desired to do his best in the sight of the commander even in his extreme difficulties the attack of the enemy was delayed for a little while (stopped to look up *paulum*), the attack of the enemy was delayed somewhat." (Q. "Are you through now?" A. "Yes." Q. "Will you read it again, please?")

"Hope having been inspired in the soldiers by his arrival and courage having been revived, since everyone desired to do his best in the sight of the commander even in his extreme difficulties, the attack of the enemy was delayed somewhat."

Time, 17 minutes.

Q. "How did you work it out?"

A. "First I read the words as they came and then arranged them so that they would have some sense."

Q. (After re-reading the last translation), "Is that a good sentence?"

A. "Yes."

Q. "What does it mean?"

A. "The soldiers fought better because they wanted to show off in front of Caesar."

Q. "Why not translate it this way:

'His arrival inspired the soldiers with hope and revived their courage. The attack of the enemy was delayed somewhat because each one wished to do his best in the presence of the commander, even though his difficulties were extreme.'?"

A. "My teacher wouldn't accept it. It's too free."

With the aid of a dictionary Mary Elizabeth can work out a translation for simple Latin if she spends enough time on it. First she analyzes the English meanings of the individual Latin words and then tries to put them together, in a partially meaningful sentence. After doing this she has some idea of the thought of individual sentences, but fails to get any connected story out of the sentences. Each sentence is a problem in itself and in her mind stands in isolation from the sentences which come before or after it. The Latin sentence which is given above is part of a story of Caesar's campaign against the *Belgae*, but Mary Elizabeth has not the slightest idea of what this war was about nor of the strategy used by the opposing forces. Apparently it has not occurred to her that Latin tells a story. On the contrary, it is a series of puzzles which provide good material for "digging," and the solutions of which give her a feeling of success and victory and a zest for tackling the next problem. It might be thought that such laborious and slow work would be extremely dull, but quite the contrary is true. Mary Elizabeth likes Latin. In fact, she puts more time on this subject than on any other of her high-school studies. Why is it so interesting in spite of the fact that the content is meaningless? Each sentence translated gives her the feeling of victory, and that makes the activity interesting. But from a practical point of view, is this work not a waste of good talent, time, and industry? Mary Elizabeth doesn't read Latin, for she gets no thought out of it, only the feeling of success.

4. High school seniors who completed four years of Latin could translate only 52 percent of the short sentences in Henmon's sentence test and only 78.7 percent of the thought units.[12]

5. Photographic studies of eye-movements show that the best third-year high-school pupils in Latin make about 45 pauses per line in trying to read Latin, while in reading English analytically they make only 9.2 pauses per line, and in story-reading, still less.[13] This shows that they do not read Latin but only look at words.

6. The decrease in the registration of Latin students from year to year is so great that those dropping out could not have learned to read Latin within the time it was studied and those continuing the study do not read it after graduation from school. Out of a thousand beginning Latin pupils only 140 complete four years of the study, only 50 continue the study in college, and only 6 refer to Latin once a year or more after graduation.[14] Of those who teach Latin, only 30 percent read new Latin from year to year.

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[12] Brueckner, Leo J., "The Status of Certain Basic Latin Skills," *Journal of Educational Research,* Vol. IX (1924), pp. 390–402.

[13] Judd, C. H., and Buswell, Guy T., *Silent Reading: A Study of Various Types.* Univ. of Chicago Press, 1922.

[14] O'Shea, M. V., *The Reading of Modern Language.* Washington, D. C.: Bureau of Education, Bulletin No. 16, 1927.

These facts justify the conclusions that Latin is not read after the requirements for graduation are met and that the uses of Latin are limited to its transfer values.

The Transfer Values

We must find the values of the study of Latin either in the benefits which it has for English or in its disciplinary and cultural effects. Possible benefits lie in an enlarged vocabulary, an increased ability to spell, a better knowledge of grammar, and an increased ability to read, write, and speak English. Even though students of Latin do enlarge their knowledge of words, grammar, and spelling, such knowledge has little value unless it produces increased skill in reading, writing, and speaking English.

The Effects of the Study of Latin on English Vocabulary

Investigations of the effect of the study of Latin on gains in knowledge of English vocabulary have been made by Starch,[15] Carr,[16] Thorndike and Ruger,[17] Woody,[18] Hamblen,[19] and Haskell.[20] As representative of the re-

[15] Starch, Daniel, "Further Experimental Data on the Value of Studying Foreign Languages," *School Review,* Vol. XXV (1917), pp. 243–248.

[16] Carr, W. L., "First-year Latin and Growth in English Vocabulary," *School and Society,* Vol. XIV (1921), pp. 192–198.

[17] Thorndike, E. L., and Ruger, G. J., "The Effect of First-year Latin upon a Knowledge of English Words of Latin Derivation," *School and Society,* Vol. XVIII (1923), pp. 260–270, 417–18.

[18] Woody, Clifford, *Report of Latin Investigation in Various High Schools of Michigan.* University of Michigan, Bureau of Educational Reference and Research, Bulletin No. 64 (March 31, 1924).

[19] Hamblen, A. A., *An Investigation to Determine the Extent to Which the Effect of the Study of Latin upon a Knowledge of English Derivatives can be Increased by Conscious Adaptation of Content and Method to the Attainment of This Objective.* Doctor's thesis, University of Pennsylvania, 1925.

[20] Haskell, Raymond I., *A Statistical Study of the Comparative Results Produced by Teaching Derivation in the Ninth-Grade Latin Classes and to Non-Latin Pupils in Four Philadelphia High Schools.* Doctor's thesis, University of Pennsylvania, 1923.

sults of this group we may take the studies of Thorndike and Ruger and of Haskell. Thorndike and Ruger made a study of the effects of first-year Latin on gains in knowledge of English vocabulary of Latin and non-Latin origins. Tests were given at the beginning, middle, and end of the ninth grade to 2,575 Latin pupils and to 2,944 non-Latin pupils. The tests used were equivalent forms of the Carr English Vocabulary Test, and consist of fifty sentences, one half containing italicized words of Latin origin and the other half containing italicized words of non-Latin origin. After each sentence there are five words, one of which is a synonym for the italicized word. The pupil's task is to mark this word, and his score is the number of words marked correctly. In words of Latin origin, the Latin pupils gained, during the year, 4.7 words as against 1.8 words by non-Latin pupils. In words of non-Latin origin, the Latin pupils gained 1.1 words as against 1.4 words by the non-Latin pupils. That is, the Latin pupils gained more than twice as many words of Latin origin than the non-Latin pupils, but in the words not of Latin origin, there was no significant difference.

The significant fact about Haskell's investigation was his finding that knowledge of Latin derivatives was considerably increased by giving special attention to them. Haskell used four groups of ninth-grade pupils for this experiment, as follows:

1. A control Latin class in which no effort was made to teach derivatives.
2. The experimental Latin class in which one fifth of the class time was used for teaching derivatives.
3. The non-Latin control class in which English alone was taught, without any work on derivatives.
4. The experimental non-Latin class in which one fifth of the class time was used to teach English derivatives from Latin.

The experiment began with about 1,800 pupils who

entered Philadelphia high schools in February 1922, and ended with 525 pupils in January 1923. At the beginning, middle, and end of the year the pupils were given the Carr English Vocabulary Test, the Thorndike Visual Vocabulary test, and the Terman Group Test of Mental Ability. The gains in vocabulary made by the various classes during the year were computed on the basis of pairing the pupils according to the initial scores in each of these tests.

The differences in gain in the English words of non-Latin origin made by the various classes were negligible, but significant differences appeared in the gain made in the Carr test in the English words of Latin origin. The English class in which no attention was given to derivatives made the smallest gain, 1.65 words. Then came the Latin class in which one fifth of the time was devoted to the teaching of derivatives, with a gain of 7.60 words. Haskell unfortunately did not give the absolute gains of the control Latin class in English words of Latin origin, but the total gains made in the Carr test indicated that this class fell between the experimental non-Latin and the experimental Latin classes.

Haskell's results are in agreement with what we should expect under the conditions of the experiment. Numerous experiments have established that when a learner, through systematic practice, undertakes the formation of a skill directed to a specific goal, his gains in this skill are far greater than in any closely related skill to which the practice is not directed. Latin classes in which one fifth of the time was devoted to learning derivatives learned more of them than Latin or English classes which gave no time to this specific activity. Similarly, English classes in which one fifth of the class time was devoted to learning Latin derivatives learned more of them than

English classes which gave no attention to them. These results are exactly what we should expect. Not so easily understood, however, is the fact that the Latin classes devoting no specific time to learning derivatives gained more knowledge of them than the English classes in which one fifth of the time was devoted to derivatives. In explaining this result we must keep in mind the nature of the major activities of the Latin class, and the time factors in the two classes. Since the major activity in the study of Latin, as now taught, is the finding of English equivalents for Latin words, the pupil simply cannot avoid learning a number of derivatives, even when they are given no special emphasis.

If we consider the total amount of time spent in Latin classes and the amount of time devoted to the study of Latin derivatives in the English class we can easily see why the study of Latin, without special emphasis on derivatives, should give more knowledge of them than the study of English in which they are emphasized. One fifth of the class time for English means 8 or 10 minutes a day. Full time to Latin means 40 or 50 minutes a day, and to this should be added about 60 minutes for study on the part of the student. We have then to compare the gains from 8 or 10 minutes of study a day with the gains from about 100 minutes of study a day. According to the Carr test, 8 or 10 minutes a day devoted to the study of derivatives yielded a gain of 6.3 words in the total test during the year, while full time devoted to Latin, or about 100 minutes a day, yielded a gain of 7.4 words in the test during the year, or just one word more out of fifty! The surprising fact, then, is not that full time given to Latin without special attention to derivatives gives a slightly larger gain in knowledge of derivatives than one fifth of the class time in English, but

rather that when a class in English devotes 8 or 10 minutes a day to the study of derivatives, it gains almost as much in knowledge of derivatives as a class giving about 100 minutes a day to the study of Latin without any special emphasis on derivatives.

The study of Latin appears to have a more beneficial effect upon knowledge of English vocabulary than the study of a modern foreign language such as French. The effect of a year's study of French upon English vocabulary was measured by Woody [21] with a scale consisting of 50 words, 25 of French origin and 25 of non-French origin. Two forms were devised, one of which was used at the beginning of the year and the other at the end of the year. They were given to 417 nonlanguage students, to 298 beginning French students, and to 303 beginning Latin students. When the gains in vocabulary were calculated in groups differentiated according to initial score, intelligence, and sex, it was found that their rank order from highest to lowest was "beginning Latin," "nonlanguage," and "beginning French." With respect to mean intelligence the advantages were in favor of the French and Latin groups, so that this factor cannot account for the superiority of the nonlanguage group over the beginning French group. This experiment indicates, therefore, that we need not study French to increase our knowledge of English words.

How Much Does the Study of Latin Increase a Pupil's Ability to Spell English Words?

Since so many English words have a Latin origin, there is a possibility that the study of Latin will increase a

[21] Woody, Clifford, "The Influence of the Teaching of First-year French on the Acquisition of English Vocabulary," *Studies in Modern-Language Teaching*, Chapter III. New York: The Macmillan Company, 1930.

pupil's ability to spell English words. The extent of this possibility was investigated by Lillian B. Lawler[22] who collected about a million spellings from the junior high schools of about 90 towns in Iowa. Her collection contained about 200 spellings of each of the 1,495 words of Latin origin in the first 2,977 words of the Anderson List. She analyzed the errors for the purpose of finding out what percent of them are inconsistent with a knowledge of Latin, that is, which errors the pupil should have avoided if he had known how the Latin root word, inflection, prefix, or suffix was spelled, and was acquainted with the rules governing Latin spelling and assimilation or combination. She calculated that about 65 percent of the errors might have been prevented by a knowledge of Latin, about 7 percent might have been caused by Latin, and that about 28 percent could not be remedied by knowledge of Latin. The way a knowledge of Latin might help in English spelling is shown in such words as *family* and *concert*, which contain unclear vowels. The corresponding Latin words accent these vowels: *família* and *concértus.* A case of interference is shown in such words as *enquiry*, the preferred British spelling of *inquiry*, and *entertain* where the Latin *in* and *inter* have changed to *en* and *enter* because of French influence. Errors due to interference might be avoided by learning rules. But consider how much the pupil must learn before he can receive these benefits. First, he must learn Latin—including the Roman pronunciation; second, he must learn the spelling of Latin; third, he must learn a number of rules to keep Latin from interfering with English spelling; and fourth, he must learn many rules on assimilation. But why take such a long and hard road to

[22] Lawler, Lillian B., *The Potential Remediability of Errors in English Spelling through the Study of High-School Latin.* Doctor's thesis, University of Iowa, 1925.

a goal? Fortunately, the American child is saved from this grind, for he learns to spell by *studying spelling,* and in most cases, knows how to spell the essential words before he begins the study of Latin. The latter, therefore, can add very little to this ability.

From a scientific viewpoint, however, it is worth while to inquire what gains in spelling are made by the study of Latin in high schools. Coxe[23] investigated this problem. He designed a spelling scale of 50 words, 25 of Latin and 25 of non-Latin origin, and gave it at the beginning, middle, and end of a school year to ninth-grade pupils in 58 high schools scattered throughout the United States. In words of Latin origin, the Latin pupils gained 3.6 words during the year while the non-Latin pupils gained 2.6 words. In words of non-Latin origin, the Latin pupils gained .2 of a word while the non-Latin pupils gained .1 of a word. According to this test, the study of first-year Latin had no effect on the spelling of non-Latin words, but during one year, Latin pupils learned to spell one more word out of 25 Latin derivatives than did non-Latin pupils. Here, again, we might inquire whether attention to spelling in the Latin class produces larger gains. We also might inquire whether more gains are made when spelling is taught in a Latin class than in a non-Latin class, and whether the gains are increased still further by developing the rules governing the spelling of Latin derivatives. Coxe made a controlled experiment to answer these questions. He used five groups, as follows:

Group I. Latin Control. Beginning Latin pupils were taught in the traditional way without relating Latin to the spelling of English words.

Group II. Latin Experimental Alpha. Beginning Latin pupils were taught the spelling of 153 English words derived from the Latin

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[23] Coxe, Warren W., "The influence of Latin in spelling of English words," *Journal of Educational Research,* Vol. IX (1924), pp. 223–233.

in the pupils' text. The similarity between the Latin and English words was pointed out but no rules were developed.

Group III. Latin Experimental Beta. Beginning Latin pupils were taught the same material as Group II with the addition of the rules governing the spelling of Latin derivatives.

Group IV. English Non-Latin Control. Pupils did not study Latin, and no special effort was made to teach spelling other than that used in the school.

Group V. English Non-Latin Experimental. Non-Latin pupils were taught spelling according to the best current practices.

The value of the procedures used may be judged from the superior gains of Groups I, II, III, and V over Group IV.

The results were that the study of Latin, even with no special emphasis upon its relation to English spelling, did have an appreciable effect on the spelling of Latin derivatives. When the similarities between English and Latin were pointed out, the gains in spelling were increased still further, but the greatest results were achieved when the rules which govern the spelling of English derivatives were developed. The most remarkable result was the smallness of the gains made in the Latin words, regardless of the method used. The gains in the non-Latin test words were negligible, but this was because the words taught were Latin derivatives. Like the experiment of Haskell, this one shows that practice systematically directed toward a specific goal produces greater gains in the direction of the goal than practice not so directed.

The Influence of the Study of Latin on Knowledge of Classical Allusions

To learn the meaning of classical allusions in English literature is said to be another value of the study of Latin. To decide whether it is a worthy objective it is necessary

to know how frequent such allusions are in literature and to find out how much the study of Latin contributes to the knowledge of such allusions. The first problem was investigated by Miss Bunyon [24] and by Miss King [25] and the second one by Miss Clark.[26]

Bunyon, with the assistance of a number of Latin teachers, counted the classical allusions in 148 books on literature recommended for high-school pupils. Fifty of them were books that had been read by the pupils in a certain high school. The count revealed a total of 2,504 references, or about 17 per book. Of these, only the following had a frequency of 15 or more in all the books examined: *Amazons, Fates, Juno, Neptune, Olympia, Titans, Minerva, Nymphs, Bacchus, Hercules, Apollo, Muses, Diana, Venus, Jupiter, Cupid, Cleopatra, Caesar,* and *gladiatorial combats.*

King counted the classical allusions appearing in sixteen leading magazines and eight leading dailies published during the year 1921, and found a total of 2,738. Those having a frequency of 20 or more were much the same as Bunyon's except that the order of frequency was different. Those not appearing as frequently in her findings were such items as *Mars, Mercury, Hercules, Atlas, Argonauts, Pan, Plato, Homer, Greece, Rome, Romans,* and *Cicero.*

Clark constructed objective tests to measure a pupil's ability to identify classical allusions, selecting those items which had the higher frequencies in the tabulations of

[24] Bunyon, Margaret F., *Classical Allusions in the English Reading of High-School Pupils.* Master's thesis, University of Wisconsin, 1922.
[25] King, Ruth B., *The Classical Allusions in Certain Newspapers and Magazines.* Master's thesis, University of Wisconsin, 1922.
[26] Clark, Grace W., *The Relative Ability of Latin and Non-Latin Pupils to Explain Classical References.* Master's thesis, University of Iowa, 1923.

Bunyon and of King. The tests were given to nearly 3,800 pupils from Grades VIII to XII, inclusive, in nearly 100 schools in the state of Iowa.

The superiority of the Latin pupils to the non-Latin pupils in knowledge of classical allusions appearing in English reading varied from 41 percent in Grade IX to 89 percent in Grade XII. Fourth-year Latin, which is the study of Vergil, was the most productive in this knowledge. This is to be expected, for Vergil is full of mythology. Even though Latin pupils do know more about Roman mythology and other classical allusions than non-Latin pupils, it still is a question whether the gain is worth the cost. The comprehension of modern English literature is not dependent on knowledge of classical allusions. Since there are only about fifteen or twenty that are important from the standpoint of frequency, could the pupil not become sufficiently familiar with them by spending a few hours studying an encyclopedia or dictionary of Roman mythology?

The Influence of the Study of Latin on Knowledge of English Grammar

An important investigation of this problem was made by Starch.[27] He, along with others, was interested in determining the effect of the study of foreign language upon English grammar and also upon ability to use English correctly. He gave tests of grammar and tests of correctness of usage to 54 university juniors and seniors and to 146 high-school pupils. The grammar tests consisted of passages in which the parts of speech were to be identified, passages in which the cases of nouns and pro-

[27] Starch, Daniel, *Educational Psychology.* New York: The Macmillan Company, 1919.

nouns were to be identified, and passages in which the modes and tenses of verbs were to be identified. The test in ability to use English consisted of 100 sentences, each containing two forms, either or both of which might be correct or incorrect. The pupil's task was to indicate the correct forms.

In his results Starch found that the fifteen university students, who had from ten to fifteen years of foreign language, had a superiority of 32.6 percent in knowledge of grammar over the twelve who had from two to five years of that study, but their superiority in the usage of English was only 6.2 percent. The three-year high-school group had a superiority of 37.5 percent over the eight-week group in knowledge of grammar, but their superiority in the use of English was only 10.9 percent. The university students who had five or more years of Latin had a superiority in knowledge of grammar of 13.1 percent over those with no Latin but a superiority of only 7.3 percent in the use of English. The study of Latin and of foreign language does seem to increase considerably one's knowledge of English grammar, but the influence on ability to use English is slight. The differences in the ability to use English between those who had much foreign language and those who had little may easily be due to differences in original ability, or to the selective influence of advanced courses. The fact, however, that the differences in knowledge of grammar were much greater than the differences in English usage was undoubtedly due to the training in English grammar given by the study of foreign language. This training may be accounted for by the grammar method of teaching foreign language, by which points in foreign grammar are usually explained by comparison with English grammar.

The Influence of the Study of Latin on Ability to Use English

We have seen that the study of Latin yields a small increase in ability to spell English words of Latin origin, a small increase in knowledge of English words of Latin origin, a considerable increase in knowledge of classical allusions appearing in English reading if the study of Latin is continued through Vergil, and a considerable increase in knowledge of English grammar. But these gains can hardly be said to be worth while in themselves unless they increase the ability to read, write, and speak English. No investigations have yet been made of the influence of the study of foreign language on the ability to speak English but its influence on English usage has been investigated by Starch,[28] Dallam,[29] Wilcox,[30] Thorndike,[31] Otis,[32] Miller and Briggs,[33] Price, Thompson, and Richards,[34] Woodring,[35] and Werner.[36] The investigation of Starch showed that the study of Latin increased considerably the knowledge of English grammar, but influenced very little the ability to use English.

A more conclusive experiment in the effect of the study

[28] *Op. cit.*

[29] Dallam, M. Theresa, "Is the Study of Latin Advantageous to the Study of English?" *Educational Review,* Vol. LIV (1917), pp. 500–503.

[30] Wilcox, M. J., "Does the Study of High-School Latin Improve High-School English?" *School and Society,* Vol. VI (1917), pp. 58–60.

[31] Thorndike, E. L., "The Influence of First-Year Latin upon the Ability to Read English," *School and Society,* Vol. XVII (1923), pp. 165–168.

[32] Otis, A. T., "The Relation of Latin to Ability in English Vocabulary and Composition," *School Review,* Vol. XXX (1922), pp. 45–50.

[33] Miller, Geo. R., and Briggs, Thomas H., "Effects of Latin Translations on English," *School Review,* Vol. XXXI (1923), pp. 756–762.

[34] Price, Wm. R., Thompson, H. G., and Richards, E. G., "Translation into English," *School and Society,* Vol. XXIV (1926), pp. 51–56.

[35] Woodring, M. N., "A Study of the Quality of English in Latin Translations," *Teachers College Contributions to Education,* No. 187. New York: Teachers College, Columbia University, 1925.

[36] Werner, Oscar H., "The Influence of the Study of Modern Foreign Languages on the Development of Abilities in English," *Modern Language Journal,* Vol. XII (1928), pp. 241–260.

of Latin on ability in English composition was made by Otis, who eliminated the factor of intelligence by selecting Latin and non-Latin groups by means of an intelligence test. She found two groups, each containing forty-two high-school pupils who made the same average score in the Terman Group-Intelligence Test. She measured their ability in English composition by having them write a composition of approximately one hundred and fifty words on one of three topics. These were rated by the Nassau Scale. She also tested their knowledge of English words of Latin origin by having them write in ten minutes as many definitions as possible of fifty Latin derivatives. Table 5 gives her results.

TABLE 5

Comparison of Latin and Non-Latin Students in Abilities in Composition and Vocabulary When Balanced for Intelligence.

(From Otis, 1922)

Group	Intelligence Score	No. Yrs. in High School	No. Yrs. in Modern Foreign-Language Study	Composition Score (Nassau)	Vocabulary-Test Score
Latin.	153.6	2.2	1.0	6.5	16.2
Non-Latin	153.6	2.6	1.7	6.1	12.2

Here there is a difference of .4 of a step in the Nassau Scale in favor of the Latin group. This is the same as the amount of gain in English composition ordinarily made by a year's training in high school. It is an appreciable difference and is greater than the size of the figure might indicate. It can hardly be attributed to differences in intelligence or in the amount of schooling or in the amount of training in modern foreign language. Some of it is doubtless due to the fact that the Latin

group consisted of pupils taking a literary and classical course, while the non-Latin group was composed principally of those taking a commercial course. The Latin group, therefore, probably had more training in English than the non-Latin group. Whether this factor is sufficient to account for the difference is not certain. It is probable that the study of Latin makes a slight addition to one's ability in English composition and a considerable addition to one's knowledge of English words of Latin origin.

If the claim that the study of Latin gives a student a fine discrimination in the use of words is justified, the Latin student should, other things being equal, be able to read English with a better degree of comprehension than the non-Latin student. This point was investigated in an extensive experiment by Thorndike, who gave the Thorndike-McCall Reading Test to several thousand Latin and non-Latin ninth-grade pupils in over a hundred schools. Form 2 was given at the beginning of the year, Form 8 at the middle of the year, and Form 4 at the end of the year. An idea of the results found may be obtained by comparing the year's gains of 254 Latin pupils and of 257 non-Latin pupils, all of whom made a score of 56 in the first test. The Latin students gained 4.6 points; the non-Latin students, 3.0 points. In general, the gain made by the Latin pupils was about one and one-half times as great as that made by the non-Latin pupils. Thorndike, however, doubted that this superiority was due to the study of Latin, inasmuch as the complete gain was made during the first half of the year. Since Latin produced no superior gain during the second half of the year, it is probable that the gain made by the Latin students during the first half was due to other causes.

Along with the possibility of improving the use of English by the study of Latin, goes the possibility of making it worse. The translations usually accepted in the study of Latin are far from being good English. Miller and Briggs collected 300 translations from third-year Latin pupils who were studying Cicero. Of these, 34 percent were so poor as to be meaningless; 40 percent might be called "translation" English; and only 2 percent were faultless English. A sample of meaningless English is the following:

> So much did I accomplish when you were repulsed by the consul as an exile you are able to ruin the republic and to vex the consul and that this crime committed by you should be called piracy rather than war.

A sample of "translation" English follows:

> Will you discover him to be an enemy, whom you see about to be waiting in the camp of the enemy, the author of the crime, the leader of a conspiracy, the summoner of slaves and abandoned citizens, permitted to go out that he might seem not being sent from the city by you but sent into the city?

Needless to say, the authors concluded that translating does more harm than good to the use of English. Even if pupils did render the Latin into good English, they would find many teachers rejecting such translations for the reason that they failed to reveal certain rules about Latin grammar and syntax.

"Translation" English is also developed in the study of modern language.

Price, Thompson, and Richards of the New York State Department of Education analyzed the quality of English found in written translations on 399 third-year French papers selected from the returns of the Regents' Examinations in June 1925. Out of this number all but 7.1 percent failed to write satisfactory English transla-

tions, although only 43.9 percent failed when their papers were read for French. The weaknesses revealed in the English translations were a restricted English vocabulary, inability to spell correctly, incomplete sentence structure, and inability to reproduce the thought of the French passage. These qualities are illustrated in some of the reproductions given of the following passage.

Le Nouveau Pensionnaire.

La femme et son fils étaient venus tous les deux en voiture. Elle était veuve, et fort riche, à ce qu' elle nous fit comprendre. Elle avait perdu le cadet de ses deux enfants, qui était mort un soir en retour de l'école, pour s'être baigné avec son frère dans un étang malsain. Elle avait décidé de mettre l'aîné, Augustin, en pension chez nous pour qu'il put suivre le Cours Superieur. Et aussitôt elle fit l'éloge de ce pensionnaire qu'elle nous amenait. Ce qu'elle contait de son fils avec admiration était fort surprenant: il aimait à lui faire plasir, et parfois il suivait le bord de la rivière, jambes nues, pendant des kilomètres, pour lui rapporter des oeufs de canards sauvages. L'autre nuit il avait découvert dans le bois une faisane prise au collet dans des nasses qu'il avait tendues.

A French teacher's translation:

The New Boarder

The woman and her son had both come in a carriage. She was a widow and very rich, as she made us understand. She had lost the younger of her two sons who had died one evening on his return from school because he got wet with his brother in an unhealthy pond. She had decided to place her older son, Augustin, in our boarding house in order that he might attend the Cours Superieur. And immediately she made the eulogy of this boarder whom she was bringing to us. What she told of her son with admiration was very surprising: he loved to please her and occasionally he followed the river bank, bare legged, for kilometers to bring her some wild ducks' eggs. The other night he had discovered in the woods a pheasant caught by the neck in some snares which he had spread.

The following is given as a typical translation of parts of this selection by a student:

She had decided to put the donkey, Augustin, in the stable at our home, in order to follow the superior course and soon she made the

path to the penitentiary by which she led us. What she counted against her son with admiration was supremely strong: he liked to please her and some times he followed the edge of the river, his legs tired, for some kilometers, in order to bring back some eggs and sausages.

She was old and very rich, to which she made us understand. She had lost the care of her two children, who had died one evening while returning from school in order to be barried by her brother in the cemetary.

The phrase "des oeufs de canards sauvages" was variously translated as:

The eggs of Canadian savages
Ears of wild corn
Beef of dog sausages
Some savage-looking horns of oxen
Eggs with hard shells
Bulls with savage horns.

The authors concluded through this study that high-school students cannot write acceptable translations of French and Latin. They believe, however, that a much better quality of translation can be produced by stressing comprehension, refusing to accept "translation English," and by increasing coöperation between the English and the foreign-language departments.

The effect of the study of modern language on various abilities in English was investigated by Werner. This study is interesting not only because of what it revealed about the transfer values of modern language but also because of what it showed about the relation of transfer to intelligence—that the amount of transfer is closely proportional to the intelligence of the student.

In his experiment, Werner gave at the beginning and end of a school year an intelligence test and a series of standardized tests in English to 678 high-school pupils, of whom 39 studied a modern foreign language and 286 did not, and to 297 college freshmen, of whom 228

studied a modern foreign language and 69 did not. "Punctuation was tested by the use of the Pressey Punctuation test, sentence structure by the use of Pressey Sentence-Structure test, the ability to discover and correct speech errors, and to select appropriate rules, with the Charter's Diagnostic Language and Grammar Test; the ability to determine the meaning of words, by the use of Test VI of the Purdue English Test; and the ability of high-school pupils as to speed and comprehension in reading, with the Monroe Standardized Silent-Reading test; same abilities in college freshmen with the Thorndike McCall Reading Scale." The high-school students studied French, Spanish, or German, while the college students studied one of these languages or Swedish or Czech. An effort was made to select groups in which the English instruction was constant. Table 6 shows the results for the modern-language and the no-modern-language groups of high-school pupils.

TABLE 6

Summary of Gains in English from Training in Modern Foreign Language Made by Different I. Q. Groups of High-School Pupils over High-School Pupils Who Did Not Study Foreign Language
(From Werner, 1928)

I. Q.	Reading Speed		Read. Comprehension (Sophomores)	Punctuation (Juniors)	Sentence Structure *	Charters Language Test (Juniors)	Charters Grammar Test *
	Soph.	Junior					
Low......	−14.60	−7.86	−1.86	−.20	−1.10	−4.80	−1.40
Average ..	−18.37	2.80	1.69	.10	−.20	−1.40	−1.50
High.....	19.79	4.69	8.87	.10	.60	3.70	3.00

*All classes

First, we notice that the gains are nearly all negative for the low and average students and positive for the superior students. The probable explanation of this is

that bright students see such relationships between English and foreign language as similarities in word-meaning and in grammatical construction. Others do not see these relationships and so are confused. The largest gains are made in speed and comprehension of reading. It is difficult to see how the study of a foreign language could make a noticeable difference in speed of reading the mother tongue, but it is possible to see how the increased knowledge of vocabulary might produce increased comprehension. Possibly the positive gains in the bright students are due to factors such as differences in growth of intelligence, or to uncontrolled training in English. Such a possibility is indicated by the fact that no significant transfer values were found in the college students who studied foreign language. This may be due, however, to the fact that some of them studied Swedish or Czech. With these comments in mind, we may accept the conclusions drawn by Werner and detailed in the following paragraph:

(a) that it is difficult to defend the general statement that the study of a modern foreign language will always aid in the development of desirable abilities in English; (b) that in general, the evidence indicates clearly that the study of modern foreign languages aids in the development of speed and comprehension in reading, especially with high-school pupils; (c) that the evidence is favorable to the conclusion that the study of modern foreign languages aids in the development of ability in grammar and in the development of vocabulary; (d) that it is doubtful whether the study of modern foreign languages aids in the development of ability to punctuate correctly, to discover faulty sentence structure or to discover speech errors and to correct them; that the evidence indicates clearly that the lower the I. Q. of a modern foreign-language pupil, the greater is the probability that the study of a modern foreign language will actually interfere with his attempt to develop desirable abilities in English; and, contrariwise, that the higher the I. Q. of a modern foreign language pupil the greater the probability that the study of a modern foreign language will influence favorably the development of such abilities.

The general conclusion from all these studies is that there is little or no justification for the claim that foreign language should be studied for its beneficial influence on English. The actual uses made of the language itself are and always must be the principal reason for its study.

How Much Does the Study of One Foreign Language Help the Learning of Another?

Studies of this problem have been made by Swift,[37] Cole,[38] Heald,[39] Kirby,[40] Rice,[41] and others. Swift studied the weekly progress of a high-school class of 48 boys and girls in first-semester Spanish. The class consisted of pupils who had had one year of Latin and one year of German, pupils who had had one year of Latin, and pupils who had had no foreign language. At the end of the second week these three groups made scores in Spanish of 92, 85, and 65 respectively. At the end of the fourteenth week, the scores were 80, 83, and 71 respectively. Those who had studied foreign language before made much better scores at the start than those who had not, but by the end of the semester the differences between the groups were considerably reduced, indicating a gradual disappearance of the initial advantage. Cole,

[37] Swift, E. J., *Mind in the Making, a Study in Mental Development.* New York: Charles Scribner's Sons, 1908.

[38] Cole, L. E., "Latin as a Preparation for French and Spanish," *School and Society,* Vol. XIX (1924), pp. 618–622.

[39] Heald, Ira F., *Relation between the Study of Latin in High School and in First-year College French.* Master's thesis, University of Iowa, 1923.

[40] Kirby, Thomas J., "Latin as a Preparation for French," *School and Society,* Vol. XVIII (1923), pp. 563–569.

[41] Rice, Geo. F., "A Study of Achievement in French and Spanish in Junior and Senior High School, with consideration of Some of the Factors That Condition Achievement Studies in Modern Language Teaching," *Publications of the American and Canadian Committees on Modern Languages,* Vol. 17, Chapter XI. New York: The Macmillan Company, 1930.

Heald, and Kirby tried to discover the influence on modern foreign language by correlating grades in high-school Latin with grades in beginning French in college. Cole also calculated the relation between amount of Latin in high school and all first-semester grades in college, as well as first-semester French and Spanish. Examining the records of 970 Oberlin students, he found 223 who took first-semester French and 105 who took first semester Spanish. He grouped these according to the number of years of Latin in high school and paired the members of the group with reference to intelligence so as to reduce the influence of general ability.

The results showed that those who had four years of high-school Latin were 6.86 points above those who had only two years of the language, but the former had an average superiority of 4.14 in all their studies, leaving a so-called specific Latin-French transfer of 2.72 points in a scale of 100. The corresponding specific Latin-Spanish transfer was 3.13 points. The phrase, "so-called specific Latin transfer" is used deliberately, for it is possible that this superiority was also due to the fact that students who take four years of Latin are commonly superior in industry and in study habits to those who take only two years. However, considering the number of common elements between Latin and the romance languages, we should expect some transfer. This is indicated by the fact that Newcomb[42] found a partial correlation of .28 between grades in Latin and Spanish, the factor of intelligence being constant. Kirby[43] found a partial correlation of .22 between grades in Latin and in French, with the factor of intelligence constant. Both

[42] Newcomb, Edith I., "A Comparison of the Latin and Non-Latin Groups in High School," *Teacher's College Record*, Vol. XXII (1922), pp. 412–422.

[43] *Loc. cit.*

found a positive relationship between the number of years of Latin and grades in French or Spanish. But the correlation is so low as to indicate only a slight influence. In fact, the aid of Latin in the study of modern foreign language may be said to be negligible in the sense that a modern language can be learned successfully without it.

The problem of the influence of the study of one modern foreign language upon another was investigated by Rice. He compared grades of students who were taking a foreign language for the first time with the grades of those who had studied another foreign language previously. His assumption was that, if there was transfer from the study of one language to another, the pupils who were taking their second language would make better grades in it than equally capable pupils who were taking that language only. He made comparisons of this sort for French and Spanish in relation to the length of study of both the first language and the second one and also on the basis of whether the first language was Latin or a modern foreign language.

The results showed that the chief advantage of previous language study appears in the initial stages of the second language and that this advantage is gradually reduced until in the third or fourth year it is all lost. One would say, therefore, that previous language study is a help in acquiring a second language, but is not a necessity. Rice concluded further that the gain in the second language is in proportion to the length of study of the first, that for success in French previous study of Latin is no more helpful than Spanish, that for success in Spanish, Latin is of no more help than French, and that the study of foreign language for one year only is of very little advantage in the learning of a second language. From these results it follows that "to learn other lan-

guages," is not a valid objective of the study of the first language, but if the latter is studied for its own sake, this may be taken as a desirable by-product.

The Influence of the Study of Foreign Language on Mental Habits

According to the committee representing the Classical Investigation, the development of correct mental habits is one of the objectives in the study of Latin. Other objectives are sustained attention, orderly procedure, perseverance, ideals of achievement and accuracy, ability to discover identical elements in different situations, and correct habits of reflective thinking. Neither the results achieved by Latin pupils nor the methods of study used by them lend any support to this objective. When 75 percent of the translations are either very bad or meaningless and only 2 percent are faultless, and when none really learn to read Latin, the study can hardly be considered good material for developing ideals of achievement and accuracy.

The investigations of Grise[44] and of Swan[45] showed that pupils have no orderly procedure in their methods of studying Latin. Each of these investigators directed lengthy questionnaires on content and method in Latin to students of Latin. Grise received replies from about 360 high-school seniors and Swan from about 650 college freshmen. Grise, whose results are confirmed by Swan's, found that a little less than half of the pupils made sure of understanding the previous section of a continuous story before beginning the study of the advance

[44] Grise, Finley C., *Content and Method in High-School Latin from the Viewpoint of Pupils and Teachers.* Doctor's thesis, George Peabody College for Teachers, 1925.

[45] Swan, Ruth, *A Study of the Content and Method of High-School Latin from the Viewpoint of College Freshmen.* Master's thesis, Indiana University, 1923.

assignment. In attacking the sentence, one half followed the order of thought in the English sentence, about one sixth first looked for the verb, and about one sixth tried to get the thought from the Latin before translating. About nine tenths followed the notes line by line, and a little over one half looked up the grammar references only when required. A little over one half looked up a new word as soon as it was met, while about two fifths tried to ascertain its meaning from the context.

With this variety of methods in studying it can scarcely be said that the study of Latin develops habits of orderly procedure. Particularly pernicious is the prevailing habit of ignoring the continuity of the story. The function of language should be to communicate thought, but less than half the pupils who study high-school Latin learn this principle from that language. It is fortunate if this habit is not transferred to the reading of English. But since little connected thought is obtained from Latin, it is difficult to see how the study of Latin is useful for developing correct habits of reflective thinking.

The Disciplinary Value of the Study of Foreign Language

There is, of course, the possibility that the exercise of thought required in translating Latin may develop somewhat the capacity for thinking in general. According to popular opinion, this influence is very great, but the only scientific study that has been made upon the extent of this influence supports the view that it is very slight. This experiment was made by Thorndike,[46] who gave, in May 1922, and in May 1923, equivalent forms of an intelligence test to 8,564 pupils from grades X, XI, and XII

[46] Thorndike, E. L., "Mental Discipline in High-School Studies," *Journal of Educational Psychology*, Vol. XV (1924), pp. 1–22, 83–89.

in 18 high schools in ten different cities. The disciplinary value of a high-school study was measured by gains in the second test over the first after due allowance was made for natural growth, effect of practice, and sex. By means of a statistical technique, which is too complicated to describe here, Thorndike calculated that 11.9 points should be allowed for effect of practice, 11.1 points for natural growth, and 3 points for a sex difference in favor of the boys. The net gain resulting for Latin and French was 1.64, placing them above physical training, English, the social studies, and the commercial and vocational studies, but below mathematics, natural sciences, arithmetic, and bookkeeping. The last two had the highest disciplinary value, represented by a gain of 2.92 points, while agriculture and biology had the least disciplinary value, represented by a loss of 0.90 points. Thorndike's conclusion was: "The facts of this experiment, if corrobrated by similar experiments, prove that the amount of general improvement due to studies is small; that the differences between studies in respect to it are small, so that the values of studies may be decided largely by consideration of the special training which they give; and that languages have no claim to prominence."

Reasons for the Widespread Opinion that the Study of Foreign Language Has Great Disciplinary Value

How has the popular conception of the great disciplinary value of foreign language, especially Latin, arisen? One reason is that Latin has been taught for centuries and its teachers have always praised its value highly. Another reason is that the subject is usually selected by superior students. Miss Newcomb [47] reported

[47] *Loc. cit.*

results which show that pupils who select Latin are superior in scholarship and ability to those who do not. The results were obtained from tests given to beginning ninth-grade pupils in over 100 schools located in 35 states. The tests were the Thorndike-McCall Reading Scale, the Carr English-Vocabulary Test, the Thorndike Test of Word Knowledge, the Charters Diagnostic Language and Grammar Test, and in some cases a group intelligence test. In all the tests except the one on reading, the results showed that from 64 to 72 percent of the Latin pupils exceeded the median of the non-Latin pupils.

Because of this superior ability they make better records in school and usually achieve a greater success in life. Not Latin but ability is the cause of this superior achievement. But laymen, as well as teachers of Latin, wrongly attributed this greater achievement to the study of Latin.

The Transfer Effects of the Study of Foreign Language in Relation to Theories of Transfer

The results obtained from the investigations of the transfer values in the study of Latin and of modern foreign language lend support to both the theory of identical elements and the theory of generalization. According to the theory of identical elements, transfer from one activity to another occurs to the extent that the two have common processes or common content. In agreement with this theory is the recognition that the study of Latin increases knowledge of English grammar, as well as ability to identify the meanings of English words of Latin origin, ability to spell such words, knowledge of classical allusions, and ability to learn other inflected foreign languages. Also in agreement with this theory

are the facts that the study of Latin does not increase one's knowledge of English words of non-Latin origin, that it has little or no effect on the ability to use English or to comprehend it in reading, and that the study of modern foreign language has no effect on ability to punctuate English sentences or on the understanding of the structure of English sentences.

According to the theory of generalization, skill is transferred from one activity to another to the extent that both are recognized as belonging to a common principle. In corroboration of this theory, it has been proved that pupils having high I. Q.'s show a greater transfer from the study of modern foreign language to knowledge of English grammar than the pupils having low I. Q.'s. In fact, the latter seem to experience interference from the study of foreign language. The most reasonable explanation for this lies in the ability of bright pupils to see how a grammatical principle applies to both native and foreign languages, while dull pupils fail to see this application. Both theories may be thought of as special cases of the principle of similarity, namely:

Transfer of skill occurs from the study of a foreign language to English to the extent that similarity between them exists or is recognized.

It is important to recognize that this principle applies to any school subject. Thus, we may take it for granted that the transfer values of other subjects will be no greater than they are for foreign languages. Applying this principle practically, it appears that the principal reason for studying a subject should be the usefulness of its content. We may recognize that the value of a subject is increased by its transfer values, but to study a subject primarily because of its transfer values is of questionable benefit.

Conclusions

After this survey of the objectives of foreign-language teaching, it is possible to state more clearly those ends which seem capable and incapable of realization under present conditions in the American schools.

The investigations of the influence of the study of modern foreign language on ability to use English and on other studies, in regard to transfer of training, show us that it is unjustifiable and unprofitable to study foreign languages in order to improve abilities in the use of English, in the forming of more correct habits of articulation and enunciation, in artistic appreciation, in the discernment of relationships, in concentration or sustained effort, in the learning of other languages, or in the forming of adequate concepts of the relation of the individual to society. The quantity and content of the materials studied, and the principal classroom activities are inadequate for giving the student a knowledge of the history, institutions, civilization, ideals, standards, and traditions of the foreign people whose language is studied. The qualifications of teachers are also inadequate for most of these objectives, and when considered in conjunction with the lack of opportunities to use a foreign language in America, they make inadvisable the attempt to teach the ability to converse with the foreigners whose language is studied. The length of time that most high-school students study a foreign language, the quantity of material studied, and the attainments of the pupils at the end of their period of study show that at least half the pupils who begin the study of a modern foreign language do not learn to read, write, or speak the language well enough to use the language for any purposes of their own. It seems, therefore, that the only objective to which the teaching of modern foreign lan-

guages in the secondary schools has a reasonable claim is the ability to read it, and when at least half the pupils fail in this objective, one becomes skeptical even of the usefulness of this aim. However, some schools can teach this ability reasonably well in two years. If all the teaching energy were concentrated upon the attainment of this one objective, there is little doubt that it could be reached by the majority of teachers. When high-school teachers once realize that their efforts toward other objectives are likely to be wasted, that in itself should be a good reason for concentrating on reading. These statements apply particularly to the objectives for the first two or three years of instruction. After the ability to read is acquired, other objectives should be sought in the order of their importance and possibility of attainment.

The study of Latin makes some contributions to ability in English. It adds to one's knowledge of words of Latin origin and their spelling, of English grammar, and of classical allusions, but it adds little to the ability to use English correctly and effectively. It often spoils a pupil's English because of the development of habits of "translation" English. Other pernicious habits often developed are those of disorderly procedure and failure to comprehend the thought of the language or the continuity of a story. This is another way of saying that the pupils do not learn to read the language, and therefore do not get the information or enjoyment that would be possible from its mastery. In view of these results it seems obvious that educators should not be satisfied with these conditions. Just what should be done to remedy the situation is a difficult question. At least three alternatives might be considered: (1) postponing the study of Latin to the college level and substituting modern foreign language, general language or some other subject; (2) requiring stu-

dents electing the study of Latin to take not less than four years of it, and (3) giving no credit for the study of Latin until the student shows a reasonable proficiency in reading it. However, the requirements for achievement in Latin should not be inconsistent with those in other subjects.

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CHAPTER 10

Foreign Language: Methods of Organization and Practice

The central problem in the study of foreign language is to obtain meaning from its individual words and connected expressions. For purposes of discussion, we prefer to treat those methods emphasizing meaning, under the principle of organization; and those emphasizing skill and facility, under the principle of practice. But in discussing the teaching of foreign language it is very difficult to separate these two principles because the same method is in one aspect a device for developing meaning; and in another, a device for developing skill. We shall therefore discuss them together.

General Methods: Grammar, Direct, and Oral

We may distinguish three general methods of teaching modern foreign language—the grammar, the direct, and the oral. The grammar method has grown up in connection with the teaching of classical languages and is very widely used in teaching the modern foreign languages. In this method, the chief objective of the first year of study is to learn the grammar of the language. Such objectives as mastering pronunciation, acquiring a vocabulary, learning the inflections of nouns and verbs, and attaining ability in translation and composition, are also emphasized but are subordinated to the mastery of grammar. The daily lesson usually includes the learning of some vocabulary, exercises in declension or conjugation,

memorization of a few rules of grammar, translation of disconnected sentences containing, among others, the new words in the vocabulary and illustrating the rules of grammar, and translation of English sentences into the foreign language for the purpose of using the grammar. Reading is usually not emphasized until the second year, and the test of this ability is invariably the translation of the foreign language into English. An exercise in translation is usually followed by formal questions on syntax and inflection. The instruction is in English, while the use of the foreign language is limited principally to pronunciation, reading, and composition.

One advantage of this method is that it makes use of the learner's previous language habits. The meanings of the foreign words are learned through their English equivalents; the foreign grammar is learned by comparison with English grammar; the pronunciation of the foreign language is learned by means of the most nearly equivalent English sounds. A second advantage is that the method makes adequate use of the adult's powers of analysis and generalization. Thus, in translating, the learner first analyzes the inflections, parts of speech, moods, and tenses, then pieces the parts together according to rules of grammar. In composing, he first states his thought in English, then thinks of the foreign equivalents, then of their proper inflections, and then puts them together according to the foreign word order. A third advantage is that translation is a convenient way of explaining the meaning of a foreign text. It provides a good test of comprehension and makes it possible to state the thought clearly.

Among the disadvantages of the method we may state, first, that the emphasis is on English rather than on the foreign language. The foreign word is always something

to be translated; its meaning, as well as its construction and syntax, is to be explained in English. Second, the foreign language is thus a medium of translation instead of a medium of thought as is the mother tongue. Third, as a consequence the foreign text remains meaningless until translated. Fourth, there is no direct association between the foreign word and its object or meaning. Fifth, the foreign language is not learned in thought units. The vocabulary is comprised nearly always of a series of unrelated words, the meaning of each of which is expressed through an English equivalent. But single words are seldom units of thought and their individual meanings are often lost in sentences. This is particularly true in idiomatic expressions as, "Never mind," "I should worry," "I'll tell the world," "Good morning," "How do you do?" It would be impossible to derive the meaning of these expressions from the meanings of the individual words. Sixth, the use of the foreign language is made a rational and conscious process whereas it should be a spontaneous and nearly unconscious process, as in the mother tongue, where the attention is on the thought and not on the language. Seventh, as a result, the use of the foreign language, whether in reading, writing, or in speaking, is always slow, halting, and labored.[1]

In the direct method the foreign language is learned by using it. The teacher speaks the foreign language in the class room and reduces to a minimum the use of the native language. Much emphasis is given to the acquisition of correct speech and to pronunciation. For the attainment of this objective there is much drill on phonetics. The grammar is for the most part learned inductively from examples of its use in the language. The

[1] Bovee, Arthur G., "Some Fallacies of Formalism," *Modern Language Journal*, Vol. VIII (1923–24), pp. 131–144.

vocabulary is taught by actions, objects, gestures, and explanations in the foreign language. Writing the foreign language is learned by copying from oral dictation and by free and spontanous composition rather than by translating sentences from the native language into the foreign language according to grammatical rules. The center of instruction is on reading the text and understanding it directly without translation. The selection is always a connected story and not a series of unrelated sentences. It is usually a classic in the foreign literature. In the classroom an effort is also made to impart a large amount of knowledge about the people who speak the foreign language as their native tongue.

The advantage claimed for this method is that it is psychological. The foreign language is learned in much the same way as is the mother tongue—through hearing and speaking. The use of objects, gestures, and demonstrations is interesting. A direct association is formed between a foreign word and its meaning, and this association is not intersected or intermediated by translation. There is thus no divergence between methods of learning and methods of use, but every function is learned and practiced as it is supposed to be used. Grammar and phonetics are understood in relation to their functions in the language. The natural and correct use of the mother tongue is preserved, for the learner is not allowed to translate until he is ready for it. The method is also economical, for every moment of the class time is used for the actual aim of the lesson. It provides for individual differences, since a pupil can choose his own vocabulary.[2] It is imperative for learning to understand the spoken language and to speak it fluently.

The direct method is open to the following criticisms:

[2] *Ibid.*

It is said not to give precise information about vocabulary and grammatical forms. It requires too much activity from the teacher and too little from the pupils. The teacher is always talking, gesturing, explaining, and demonstrating, while the pupils have nothing to do but listen—even that they often fail to do. The requirement not to use the native tongue wastes much time, since it results in long circumlocutions which could be avoided by brief explanations in the pupil's own tongue. For a number of months the pupils have no opportunity for home study, since this would mean using the native language.

The great amount of time devoted to phonetics, pronunciation, and conversation is largely wasted in American schools, for outside of class there is no occasion to converse in the foreign tongue. Consequently, there is no need of learning exact pronunciation. The latter is not learned in most American schools, in any event, for the teachers are not trained to pronounce the foreign language well. The direct method can be used successfully only by a gifted teacher who has had a long residence in the foreign country and who has acquired an insight into the customs and manners of the people. Then, too, it is adapted only to small classes of ten pupils or less, for with larger classes it is impossible to secure sufficient practice in pronunciation and conversation. In most American schools these conditions cannot be satisfied.

Other Methods

Besides the grammar and the direct methods there are numerous others which are, in large part, either varieties of one of these two or mixtures of them. One of these is called the natural method, which is distinguished from

the direct in that it teaches no grammar, reading, phonetics, or translation until the spoken language is learned. Another is called the oral method, which is used and advocated by H. E. Palmer[8] of England. It is distinguished from the direct method by its exclusion of grammar, phonetics, reading, and writing. It depends solely on ear work and aims to teach only the ability to understand the spoken language and to speak it. The claim is made, however, that it is also the shortest road to a mastery of reading and writing. Palmer bases the method on the following principles and rules:

1. The pupil must prepare himself by suppressing his powers of analysis and forcing himself to learn by his unconscious and spontaneous habit-forming processes, such as exercises in listening, articulation, mimicry, and immediate comprehension.

2. Language-learning is a case of forming habits which function automatically. In forming these habits, explanations of why's and wherefore's should be avoided, as they give no help.

3. All expressions by the pupil should be given accurately. He should not give them until he is ready and should have no opportunity to learn an inaccuracy.

4. The material should be properly graded. The following applications are made: ears before eyes, reception before reproduction, oral repetition before reading, immediate before prolonged memory, chorus work before individual work, drill work before free work.

5. To make complete mastery possible a balance must be maintained among the various branches of linguistics, such as phonetics, orthography, etymology, syntax, and semantics, as well as in choosing vocabulary, amount of drill, amount of free work, and amount of intensive or extensive reading.

6. Make the instruction concrete by teaching by example rather than by precept. Give many examples and choose them from the immediate environment of the pupil.

7. Make the work interesting by eliminating bewilderment, giving the pupil a sense of progress, and introducing competition and games.

8. Follow a rational order of progression. First learn to form sounds, then memorize sentences, then form sentences and then words.

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[8] Palmer, Harold E., *The Principles of Language Study*. Yonkers, N. Y.: World Book Company, 1921. Also *The Oral Method of Teaching Languages*. *Ibid.*, 1922.

9. Use everything that helps in the work. Don't depend much on grammar. Use other methods.

The great merit of this method lies in its emphasis on the formation of habits relating to the use of the language. It is well adapted for the purpose intended—acquiring command of the spoken language. It also seems to be better adapted to children than to adults, for it is much easier for children to use their spontaneous capacities. The method is open to criticism in the theory that learning the spoken language is the shortest method of learning to read and write, and in the theory that an adult should learn a language without the use of his powers of analysis and generalization. Each of these theories is in need of investigation and demonstration.

The claims for and against each method are matters partly of theory and partly of experience, but very few of them are demonstrations of experiment. It is doubtful whether experiments will prove any single method to be the best. First of all, the methods discussed—direct, indirect, natural, and oral—do not stand for uniform procedures, but differ widely according to such conditions as age and number of pupils, special abilities and difficulties of pupils, objectives of the course, kind and amount of equipment, and preparation and ability of the teacher. Second, even teachers who claim to follow one of the methods do not teach the same way. They disagree about some of the essential procedures, the materials to be used, and the order in which different topics are to be learned. Third, the same teachers do not follow the same procedures year after year. Fourth, at best a general method consists of a number of specific procedures. An experiment cannot prove the value of all of them as a total, but only the value of the specific parts. For these reasons there can be no single best method under all

conditions, but there can be a best method under specific conditions. We shall now turn to the experimental studies and try to learn what methods have the advantages from the standpoint of experimental results.

Experimental Studies on General Methods

Buswell's experiment. As yet insufficient experiments have been made to enable us to decide what method or methods are superior. There are three, however, on the direct and grammar methods that may be noticed, and another compares the grammar method with a mixed method which emphasizes reading. The experiments on the direct and grammar methods were made by Buswell,[4] Pargment,[5] and Peters.[6] Buswell investigated the eye movements of students and readers of modern foreign languages in relation to the grade of the student, the kind of language, and the method of instruction. Eye movements show the facility and speed of reading but are not an index of comprehension. As an illustration of the former, Buswell described the eye movements of John, a high-school student who had studied French for a period of twelve weeks, and of Miss *B.*, a graduate student who had studied French for seven years, spent some time in France, and taught French for three years. John read orally at the rate of 54 words a minute while Miss *B.* read at the rate of 276 words a minute. John could give no account of what he had read, his attention being centered on pronunciation, while Miss *B.* could give an account of all that she had read. Photographic records

[4] Buswell, Guy T., *A Laboratory Study of the Reading of Modern Foreign Languages* (A report made for the Modern Foreign Language Study). New York: The Macmillan Company, 1928.

[5] Pargment, M. S., "The Effect on Achievement of Method Used," *Modern Language Journal,* Vol. XI (1927), pp. 502–512.

[6] Peters, Mary Olga, "An Experimental Comparison of Grammar—Translation Method and Direct Method in the Teaching of French," *Modern Language Journal,* Vol. XVIII (1934), pp. 528–542.

of eye movements showed that John made an average of 21.5 fixations per line while Miss *B*. made only 7 fixations per line. John made .73 regressive or backward movements per line while Miss *B*. made only one regressive movement in an entire paragraph. John required an average of .476 seconds per fixation while Miss *B*. required an average of only .308 seconds. The number of regressive movements and the duration of the fixations may be taken as measures of the effectiveness of the reading habits of John and of Miss *B*. They also show the characteristic eye movements of a very good reader and of a very poor one.

In the part of his investigation relating to the effect on eye movements of the method of teaching, Buswell secured photographic records from 31 pupils in two Chicago high schools, 26 in school *A* and 15 in school *B*. In school *A* the direct method was used, while in school *B* the indirect or grammar method was used. In each school, there were two classes taught by one instructor. Each had long experience in his method. Records of the silent reading of three selections and of the oral reading of one selection were taken, and from them the group medians for the number of fixations per line, the number of regressive movements per line and the duration of the fixations per line were calculated.

All the pupils in school *A* showed satisfactory comprehension. In school *B*, all the second-year pupils were likewise satisfactory, but only 5 out of 7 first-year pupils were satisfactory in comprehension.

The results showed that the grammar method had the advantage in the number of fixations in the first year. However, since the first-year pupils using this method comprehended less well, this advantage had little importance. In the second year, the direct-method pupils

had, on the average, 22 percent fewer pauses per line than the grammar-method pupils. In number of regressive movements, the grammar-method pupils again had the advantage during the first year, but once more this advantage turned in favor of the direct-method pupils for the second year, when the direct-method pupils made 35 percent fewer regressive movements per line in silent reading and 24 percent fewer in oral reading. In duration of pauses, the direct-method pupils had the advantage during the first year in both oral and silent reading, but in the second year they lost it in silent reading although retaining it in oral reading. The differences in the second year, however, were small. When it is considered that the direct-method pupils had much advantage in the number of fixations and of regressive movements, it may be concluded that they were superior in ability to read.

Pargment's experiment. Pargment's experiment was made on four classes of college freshmen. Two of the classes, one with each method, were under one instructor. The other two classes had different instructors of equal ability. The direct and grammar methods had the characteristics described above. Tests of progress were given at the end of the first six weeks, the first semester, and the second semester. The final examination was the same for the four classes and consisted of the following parts:

1. Oral comprehension tests. *15 credits.*
2. American Council French-grammar tests. *25 credits.*
3. Written translation into French of ten English sentences. *10 credits.*
4. Written answers in French to ten questions expressed in English. *10 credits.*
5. Written translation into English of five French passages, from six to eight lines long, drawn from the common reader. *26 credits.*
6. Direct comprehension tests of the type of Coleman's test—seven questions. *14 credits.*

The results were that the grammar-method classes came out ahead in every test except the first, that of oral comprehension. In tests 2, 3, 4, and 5, the grammar-method classes might have been expected to do better than the direct-method classes because they had had considerable practice in these types of exercises, but it is surprising that they did better in test 6, that of direct comprehension, in which the direct-method classes had far more training. Some of the disadvantages of the direct-method classes were that the pupils had little or no home study since they were not allowed to use a foreign-native dictionary, and the necessity of first acquiring a good pronunciation. The direct-method students could only read about half as much in class as the grammar-method students because of the long explanations necessary in French to make a point clear. Pargment expressed the belief that if one more semester could have been devoted to the assimilation and reproduction of the language, with reading postponed to a later period, the direct-method classes would have achieved much better results. He concluded that the pure direct method cannot be successfully used in a two-year course without sacrificing the most important objective of the course—an intelligent reading knowledge of the language.

It is probable that the direct method should be modified somewhat in a two-year college course. A teacher may give most of the instruction in the foreign language but may make explanation in the native tongue when it saves a good deal of time. Students might also be allowed to do home study with the aid of a foreign-native dictionary. The experiment should be repeated with these modifications. In addition, the time for study in the two methods should be kept constant, and the final

test should be arranged so that they favor one method no more than another. In Pargment's experiments the grammar-method students apparently spent far more time in study out of class than the direct-method students, and four of the six final tests favored their class procedures, while only two favored those of the direct-method students.

Peters's experiment. In the experiment made by Peters, a group of twenty-eight college freshmen was divided into two as nearly equal groups as possible. One group was taught by the direct, and the other, by the grammar method. The direct method was characterized by much attention to pronunciation, extensive oral work in the foreign tongue, inductive grammar, written work based on matter heard and spoken, little translation, and much reading and use of concrete objects. The grammar method emphasized the learning of disconnected vocabulary pairs, memorization of rules of grammar, oral translation, written translation, teaching of pronunciation, and practice in reading aloud. The improvement as measured by objective tests showed significant differences in favor of the grammar method during the first semester and in favor of the direct method during the second semester. The grammar-method pupils achieved better results in translation, vocabulary, and reading comprehension; the direct-method pupils in dictation, reading, pronunciation, aural comprehension, appreciation, and grammar. From this it appears that each method secures advantages in those phases which it emphasizes most. Grammar, however, is an exception to this rule, although this may be due to the use of the inductive method.

A mixed method with emphasis on reading. Young,[7]

[7] Young, Charles E., "The Direct Method, Its Possibilities and Limitations in Iowa Schools," *Modern Language Journal*, Vol. VI (1921–22), pp. 203–208.

in coöperation with his colleagues, Beke and Daus, made some experiments on the value of a mixed method of teaching French in which the emphasis was on reading. Young and Beke[8] worked out the plan for second-year college students of French while Young and Daus worked it out for the first-year course. In the second-year course, seven sections containing 154 students took part, one of these acting as an experimental group which received special instruction and the other six sections serving as control groups. In the first-year course, twelve sections containing 294 students took part. Six of these sections constituted the experimental groups and received the special instruction while the other six constituted the control group which was taught by the traditional grammar method and which attempted to acquire a little skill in several aspects of the language. The following procedures were used with the experimental groups:

Grammar. This material was presented from a French-English point of view. It was prepared in mimeographed form, included the thirty most common irregular verbs, was completed during the first semester and reviewed in the second semester.

Vocabulary. During the first semester the first 500 words of Henmon's list were given at the rate of 30 to 35 per week. An occasional review list of larger units was given. During the second semester, the second 500 words of the Henmon list were given in a similar manner.

Idioms. Each time a new reading test was begun, the classes were given a list of idioms compiled from the text and were asked to learn them.

Pronunciation. This was taught by a set of simple definitions and rules. No attempt was made to teach details. Practice was required and students were frequently assigned pages for oral reading.

Reading. An easy test was begun at the end of the second week. At first there was careful translation but gradually the students' efforts were shifted from translation to comprehension, and questions

[8] Young, Charles E., and Beke, Geo. E. G., "An Experiment in Second-Year French," *Modern Language Journal*, Vol. XI (1926–27), pp. 25–31.

on content took the place of translation. The questions were sometimes in French and sometimes in English although the answers were always given in English.

Ear-Training. Although this training was secondary, students were often required to close books, listen to oral reading by the teacher, and reproduce the content. There were questions in French, and during the second semester, some of the ordinary class business was carried on in French.

Objective tests. These were given at regular intervals during the semester. The results were recorded in a Record Book. The students were informed of their scores so that each one knew his particular deficiencies. At the end of each semester, all sections were given an examination uniformly objective with the exception of two questions on grammar and verbs. At the end of the first semester 152 students in the experimental group and 142 students in the control group took the final examination. At the end of the second semester 134 students in each of the groups took it.

The most significant scores were those obtained from the entire final examination, for the first-year students, and for the achievement percentiles, for the second-year students. These scores showed that the experimental groups were far superior, and significantly so in the comprehension tests and in the vocabulary test at the end of the second semester. This group was also superior in the other tests, but the differences were not large enough to be significant. They had some value, however, since the placement or intelligence tests had shown the two groups to be equal in ability.

The superiority of the experimental group was probably due to the following factors in the procedures used: The grammar was limited to the minimum essentials that function in the reading of the language, and was taught in the most economical way, that is, by means of the English language. The vocabulary taught consisted of the words having the highest frequency in the language, and was systematically reviewed. There was sufficient work in pronunciation and in oral work to give

the students familiarity with the sound of the language. The reading was easy and carefully graded. The objective tests were sufficiently frequent and detailed to keep the student informed not only of his progress but also of his deficiencies. This not only gave him a motive for work but also enabled him to know at what points to apply his efforts.

The good results obtained by these procedures indicate that they are worthy of imitation in other institutions and that a mixed method, such as used here, is better adapted to American students than is either the grammar or the direct method.

Besides the above experiments on general methods there are a number of experiments on specific devices, including methods of learning a vocabulary, the laboratory method, the method of free composition, and the use of correspondence.

Experimental Studies on Methods of Learning Vocabularies

Learning by the recitation method. Various methods of learning vocabularies have been investigated experimentally and several important suggestions have come from these studies. The first of these is to learn by the recitation method rather than by the silent-reading method. Experiments justifying this procedure were made by Witasek,[9] Gates,[10] Balban,[11] and the author.[12]

[9] Witasek, S., *Ueber Lesen und Rezitieren in ihren Beziehungen zum Gedächtnis.* Zeitschrift f. Psychologie u. Physiologie d. Sinnesorganen, 1907, pp. 161–246.

[10] Gates, A. I., *Recitation as a Factor in Memorizing.* Archives of Psychology, 1917.

[11] Balban, A., *Über den Unterschied des logischen und des mechanischen Gedächtnisses Ztschr.* für Psychol, 1910, pp. 379–400.

[12] Reed, Homer B., "Repetition and Association in Learning," *Pedagogical Seminary,* Vol. XXXI (1924), pp. 147–155; also "Associative Aids: I. Their Relation to Learning, Retention, and Other Associations," *Psychological Review,* Vol. XXV (1918), pp. 128–156.

Witasek tested the retentive value of the recitation method by varying the proportion of active and passive readings in the learning of nonsense syllables. In an active reading the learner attempted to recite a row of these syllables from memory, while in a passive reading he merely read it. Retention was measured by the length of time required to memorize a row completely one hour after the first series of readings. The results were in favor of the active readings. For example, a row that had eleven passive and no active readings required 236 seconds for memorization. On the other hand, a row that had six passive and five active readings required only 143 seconds to be memorized.

Gates investigated the same problem by varying the time between passive and active readings and measuring retention by the amount remembered immediately after the reading and again after four hours. A passive reading was a silent reading, while an active reading was an attempt to recite from memory, looking at the copy only when necessary. Gates used rows of nonsense syllables, as well as selections of prose. The results were that more than twice as much was remembered immediately after the reading when four fifths of the time had been devoted to recitation than when all the time had been given to reading, and after four hours the recitation method was three times as effective as the silent-reading method. Similar results were obtained from the prose selections, but the increase in retention in proportion to the time devoted to recitation was not nearly so great.

Forming associations between the foreign word and the English equivalent. Experiments justifying this process were made by Balban and by the author.

Balban had subjects learn word pairs by two methods:

(1) by merely repeating them in a mechanical fashion, and (2) by establishing associative bonds between the pairs. Retention was tested immediately after the learning by presenting to the subject the first word of the pair and asking him to give the second. It was found that 75 percent of the pairs learned by the associative method were retained as against only 3 percent of those learned by the mechanical method. The author sought to find out why some word pairs were more easily learned and better remembered than others. In an experiment, he had twenty-seven college students learn four lists of ten word pairs. One of these consisted of German-English vocabularies, one of nonsense-syllable pairs, and two of disconnected English word pairs. In the first presentation he read the word pairs to the subject and required him to repeat. Afterwards he gave only the first word of a pair and asked the subject to give the second. If he failed, he was prompted; if he succeeded, the pair was considered learned, and the subject was asked to report what associations he had formed, if any. A record was kept of these reports and of the reaction time of each response to the stimulus of the first word. The procedure, except the reading of the pairs by the experimenter, was repeated on the second day. The word pairs were then separated into two classes: (1) those remembered on the second day, and (2) those forgotten on the second day. The following calculations were made for each class: the average learning time the first day, the average learning time the second day, the total number of pairs learned, the percent of pairs having associations the first day, and the percent of pairs having associations the second day. The results are given in Table 7.

Of the pairs that were remembered on the second day without prompting, four fifths had associations on the

TABLE 7

THE RELATION OF ASSOCIATIVE AIDS TO THE EASE OF LEARNING AND FORGETTING WORD-PAIRS

(From Reed, 1918)

Pairs Remembered or Forgotten on 2nd Day	Average No. of Seconds to Learn		Pct. of Time Saved in Relearning	No. of Pairs	Percent of Pairs Having Associations	
	1st Day	2nd Day			1st Day	2nd Day
Pairs remembered.	7.63	2.31	69	512	79	67
Pairs forgotten....	12.41	8.34	32	419	33	5

first day and two thirds had associations on the second day. Of the pairs that were forgotten on the second day, only one third had associations on the first day and only one twentieth on the second day. The reason for this great reduction was that the associations were for the most part irrelevant and illogical. On the other hand, if the associations were relevant they were retained, as were the words which they united. It should also be noted that the remembered pairs required only a little more than half as much time to learn on the first day as the forgotten pairs, and only one fourth as much time to relearn on the second day. The formation of associations or of an organization thus appears to be the key to easy learning and easy retention. In this experiment the associations were not formed artificially or intentionally, as in Balban's experiment, but spontaneously. There is no reason to believe, however, that associations formed intentionally and by a process of voluntary analysis would not be equally effective.

Spending part of the study time in recalling the equivalents. An experiment showing the value of recall in learning word pairs was made by Webb,[18] who compared a recall with a repetitive method of study. In the re-

[18] Webb, L. W., "A Comparison of Two Methods of Studying with Applications to Foreign Language," *School Review*, Vol. XXIX (1921), pp. 48–67.

petitive method, the learner spent five minutes in repeating a list of fifteen word pairs, each consisting of a proper name and an adjective. In the recall method, the learner spent three minutes in repeating the pairs and two minutes in recalling the response words and writing them down. There was a short interval between the two periods for exchanging papers. The experiment was made on two groups of college students, Group *A*, which had 37 students, and Group *B*, which had 29 subjects. Each of them learned a series by each of the two methods.

On the average the results showed that the recall method was about 25 percent superior, but it was not uniformly superior for all the subjects. Nearly one fourth of the pupils found it inferior and about one tenth found no difference between the two methods. Webb tried a similar experiment on a third group of college students in learning Hebrew-English vocabularies. In this case, the recall method was over 100 percent superior to the repetitive method. In other experiments Webb found it advantageous to present the stimulus words in the same order in the testing as in the learning and to have the learner write the response words during the recall period. He recommends the recall method for learning vocabularies—using the advantages both of serial order and of writing. According to an experiment by Thorndike,[14] however, there is no advantage in using the recall method. In his experiment, twenty-eight adults learned four series of word pairs. The first and third series were learned by reading the pairs, then covering the first word and recalling the second, then reading again and recalling, and so on until the series were learned. The second and fourth series were learned by repeating them until memorized, eleven students taking part in the experiments.

[14] Thorndike, E. L., "Repetition vs. Recall in Memorizing Vocabularies," *Journal of Educational Psychology*, Vol. V (1914), p. 596.

Time records were kept and showed no advantage in the recall method. The disagreement with the results of Webb may be due to the fact that the reading and the recalling alternated with each other, while in Webb's experiment the reading preceded the recalling and was continued long enough to make a good impression. Webb's experiment is supported by those of Witasek and of Gates on active and passive reading, but further experimentation is needed to find the cause of the disagreement and to establish more firmly the value of the recall method.

Greater Effectiveness of Oral as Against Silent Study

Seibert[15] made an experiment in which the oral method of study was found to be superior. She investigated three methods of learning English-French vocabularies, namely: (1) reading silently, (2) reading aloud, and (3) reading aloud with attempted recall in writing after each reading. In her experimental procedure she took care that none of the words were known in advance of the training, and divided the vocabularies into three series of equal difficulty. They were learned by 81 college students, who were divided into three groups; each group learned a series by each method. The vocabularies were studied until the learner could give the French equivalent of each English word twice, without error. Each list was relearned after 2, 10, and 42 days. An accuracy test was given 50 minutes after the first learning and before each relearning, the students writing the French equivalents of the English words, the order of which was changed in each test. The measures used to determine the efficiency of each method were the time required to learn or relearn,

[15] Seibert, Louise C., "An Experiment in Learning French Vocabulary," *Journal of Educational Psychology*, Vol. XVIII (1927), pp. 294–309.

and the percent of pairs remembered in the accuracy tests.

According to the results, studying aloud with written recall was first in time of learning, second in time of relearning, and first in accuracy. Studying aloud only was second in learning, and third in accuracy. Silent study was third in learning, third in relearning, and second in accuracy.

The Direct and Indirect Methods of Learning Vocabularies

A number of experiments have been made on what might be called the direct and translation methods of learning vocabularies. The results, however, are not consistent and it is difficult to draw definite conclusions from them. On the one hand, we can say that the experiments of Peterson,[16] Braunshausen,[17] and Schoenherr[18] agreed that object-word associations are more easily learned and retained than word-word associations. The experiment of Schleuter confirmed this result for object-foreign word associations but not for foreign word-native word associations. The experiment of Scholtkowska[19] confirmed it for the retention of concrete nouns and for the immediate recall of prepositions and verbs, but not for delayed retention of prepositions and verbs or for adverbial phrases. The experiment of Schmidt[20] confirmed it for verbs

[16] Peterson, Harvey A., "Recall of Words, Objects, and Movements," *Psychological Review Monograph Supplement,* Vol. IV (1903), pp. 207–233.

[17] Braunshausen, N., Les méthodes d'enseignement des langues étrangères," *Revue Psychologique,* Vol. III (1910), pp. 298–306.

[18] Schoenherr, W., *Direkte und indirekte Methode in neusprachlichen Unterricht.* Leipzig: Quelle & Meyer, 1915.

[19] Scholtkowska, Gita, "Experimentelle Beiträge zur Frage der direkten und der indirekten Methode in neusprachlichen Unterricht," *Ztsch. f. Angew. Psych,* 1925, pp. 65–87.

[20] Schmidt, Austin C., *The Effect of Objective Presentation on the Learning and Retention of a Latin Vocabulary.* Chicago: Loyola University Press, 1923.

but not for nouns and adjectives. The experiment of Netschajeff[21] showed that word-word associations are more easily formed and retained. According to Schleuter this is true for tests requiring translation of foreign words into native words. According to Scholtkowska, it is true for learning of nouns in adverbial combinations, delayed retention of prepositions and verbs, and for the free formation of new sentences. That object-word associations should be more easily formed and retained than word-word associations seems reasonable because memory experiments show that objects are more easily remembered than words—the impression is more vivid, and the ease of forming associations is far greater. The contrary results of Netschajeff may be the outcome of making the experiment on adults trained in the grammar-translation methods of learning foreign languages, or may be due to the nature of the words used. The results of Schleuter[22] may be interpreted on the basis of similarity between methods of learning and of testing.

If a test requires translating a foreign word into a native word, it is reasonable to suppose that the most economical way of learning would be through the study of word pairs consisting of the foreign word and the native equivalent. On the other hand, if a test requires the subject to give the names of objects in the foreign language or the translation of native words into foreign words, it is reasonable to suppose that the direct method would be the most economical, for it keeps the foreign language vividly in the foreground. This explanation would not

[21] Netschajeff, A., Psychologische Beobachtugen zur Frage über den fremdländeschen Sprachunterricht, *Pädagogisch-Psychologische Studien*, Vol. IX, Nos. 1 and 2, 1908.

[22] Schleuter, Louise, "Experimentelle Beiträge zur Prüfung der Anschauungs- und der Uebersetzungsmethode bei der Einführung in einem fremdsprachlichen Wortschatz," *Zeit. f. Psychologie*, 1914, Part I, LXVIII, pp. 1–114.

apply, however, to the results of Scholtkowska, which do not fall in with an established psychological principle and most likely are due to accidental factors. Further experimentation is needed to clear up the inconsistencies, but the results so far point to the following conclusions regarding the learning of vocabularies in list or serial form: object-word associations are more easily formed and retained than word-word associations, but the economy of this procedure is conditioned by the purpose of the learner. If the purpose is readiness to give a foreign word when an object is presented. the direct method is the better; if the purpose is to give a native word for a foreign word, the translation method is equally good or better, except in case of verbs.

Learning Vocabularies from Context and by Other Methods

All the above experiments relate to learning vocabularies in lists or series. There is, however, another method of acquiring the meaning of words—by figuring them out from the context. Grindstead,[23] working upon himself as subject, found that he remembered 92 percent of those words learned by the context method and 85.3 percent of those learned by the list method. The experiment was too limited to have any value except the suggestion that this method of acquiring a vocabulary should be thoroughly investigated.

The context method of study is far from simple and involves may types of reasoning. Hagbolt [24] has pointed out a number of ways in which the meaning of new words may be inferred. Some of these are the following:

[23] Grinstead, Wren J., "An Experiment in the Learning of Foreign Words," *Journal of Educational Psychology*, Vol. VI (1915), pp. 242–245.
[24] Hagbolt, Peter, "On Inference in Reading," *Modern Language Journal*, Vol. XI (1926–27), pp. 73–78.

1. Some other foreign word may give the meaning. For example, the meaning of *grande* in Spanish may be inferred from *grand* in French or *grandis* in Latin.

2. The foreign word may have the same form and meaning as the native word, as, the German words, *Wind, Hand, Winter, Warm.*

3. The meaning may be conveyed by the sound, as, "In dürren Blättern *säusselt* der Wind."

4. The meaning of an unknown word may be inferred from the known. For example, "Cette promenade etait un *supplice,* pour moi." The description that follows suggests that *supplice* means *punishment.*

5. Inference from known relations of things, as, "Die Tür drehte sich in den *Angeln.*" *Angeln* must mean *hinges.*

6. Inference from genus to species or the reverse, as, "Das Bett und die anderen *Möbel* waren alle einfach." *Möbel* must mean *pieces of furniture.*

7. Inference based on the similarity of set phrases in the foreign and in the native language. For example, "Man hatte aber auch einen trefflichen Überblick über das alte Dorf, *und benutzte die Gelegenheit,"—seized the opportunity.*

According to Bovée [25] the direct method of teaching vocabularies covers not only object-word associations and the various context methods, but a great number of others. He names twenty-one devices in all, which are given below:

1. Showing object.
2. Showing picture of object.
3. Questions on utility of object.
4. Gesturing.
5. Performing complete action before student.
6. Questions on purpose of an action: "Pourquoi étudiez vous?" "Pour apprendre."
7. Logical sequence to an action: "J'ouvre la porte"; "j'entre dans la maison."
8. Example: "Chicago est une ville"; "Paris est une ville."
9. Giving the reason for going to a place: "Je vais au garage pour chercher l'auto."
10. Opposites: "Le contraire du verbe *acheter* est *vendre.*"
11. Definition: "*Assez* signifie une quantité suffisante"; "*beaucoup* signifie une grande quantité."

[25] Bovée, A. G., "Teaching Vocabulary by the Direct Method," *Modern Language Journal,* Vol. IV (1919), pp. 63–72.

12. Similarity to English: *décider, parser,* une *quantité.*

13. Synonyms: *parle* et *cause, très* et *bien, brave* et *courageux.*

14. Logical connection of cause and effect or condition: "Il reste chez lui; il est malade."

15. Proper time or place for action: "Qu'est-ce que vous faites la nuit?" "Je dors."

16. Characterization of an object: "Cette boite-ci est petite; cette boite-là est grande."

17. Numerical processes: "Soixante minutes font une heure; vingt-quatre heures font un jour."

18. Situation: "Quand on dit 'merci,' je dois répondre 'il n'y a pas de quoi'."

19. Manner in which an action happens: "Je marchais vers l'école quand, tout à coup, j'ai entendu une explosion terrible."

20. Pointing out grammatical relations, such as verb to noun, adjective to noun, adjective to adverb, and noun to verb: *un voyage, voyager; une visite, visiter.*

21. Context: "Monsieur, j'ai appris cela hier, mais je ne peux pas vous répondre aujourd'hui, parce que je l'ai oublié."

In view of the numerous ways in which vocabularies may be learned by direct method, it is not possible to make definite statements about "best" methods until we have some experimental results on the economy of each device. It is interesting to notice, however, the rich variety of devices available.

Experiments on Various Other Phases of Learning a Language

Besides the experiments on methods of learning a vocabulary, there are scattered experiments on various phases of language-teaching, such as the use of familiar material in increasing speed and comprehension in reading, the use of the laboratory method in teaching beginners, and the use of free composition in developing ability to write a foreign language.

The use of familiar material for developing reading ability. The value of using familiar material to increase speed and comprehension in reading a foreign language

was tested by Hagbolt,[26] who divided a beginners' class in German into four sections, two of which used familiar material in its outside reading, while the others used the usual unfamiliar material in textbooks. The familiar material consisted of German translations of *Hamlet*, the Bible, stories by Christian Wahrschaffe, and others. At the end of twelve weeks, all students from both sections were given a thirty-minute test in speed of reading, which was followed by a comprehension test of sixteen questions. The two groups were compared for number of pages read, questions answered correctly, and number of errors made.

The results showed that the sections using the familiar material were from fifteen to twenty percent superior in speed, comprehension, and accuracy, to those using unfamiliar material.

Applications from experiments in learning to read a native language. Hagbolt's experiment suggests the value of attacking the problem of learning to read a foreign language by the experimental method. Notwithstanding the fact that the ability to read is the most important objective in teaching a foreign language, the number of experiments in this phase of language-learning is very limited. A large number have, however, been made on children in learning to read a native language, and many of the results can readily be applied to developing speed in reading a foreign language:

First, use carefully graded materials, beginning with the very easy ones. Little attention is paid to this principle. In the first year, the reading material often consists of disconnected sentences, and in the second year, a difficult text is the rule. This is particularly true in

[26] Hagbolt, Peter, "An Experiment in Reading Known Material in Beginning Classes," *Modern Language Journal*, Vol. IX (1924–25), pp. 345–352.

Latin, where Caesar is the traditional stand-by. These conditions could be greatly improved by careful grading. Second, use interesting material, and much of it. Facility in reading is partly a result of extensive reading, and this is made possible by selecting interesting and easy materials. The quantity of reading material assigned in a foreign language is less than one tenth of the amount which we think necessary for learning to read our native language. If the latter requires thousands of pages, there is no reason to suppose that learning to read a foreign language requires less. Third, increase the span of perception and the eye-voice span. Flash-card exercises in which the copy is gradually increased from short words to phrases, idiomatic expressions, and sentences, are useful for this purpose. They increase not only the quickness of perception but also its scope, and so make possible a greater speed. Fourth, use silent reading with a suppression of lip and tongue movements. A number of experiments have shown that silent reading is much more rapid than oral and that its speed is retarded by lip and tongue movements. Fifth, use time-limit tests in rapid silent reading and follow this with a reproduction of what has been read. O'Brien found that this device not only resulted in an immense increase in speed of reading but also prevented a loss in comprehension. Sixth, keep a curve of progress showing the amount read from day to day. This gives a motive for improvement and causes a persistent effort to make the curve rise from day to day.

These are among the more important devices that are helpful in increasing speed, but there are cases requiring devices that apply only to an individual, such as choosing of selections that appeal to the special interests of the reader, exercises in recognizing thought units, accurate oral reading of familiar stories, exercises in analyzing and

recognizing phonetic elements, exercises in dividing long words into syllables, and practice in making accurate return sweeps.

In addition to showing a number of devices for increasing speed, experimental studies of learning to read a native language show a number of devices for increasing comprehension. These are stated on pages 144–148.

An experiment on the laboratory method of learning French. The laboratory method was used by Caroline House in teaching first-year French to a group of high-school pupils. She claims that this method remedies "the one greatest fault of language-teaching—the lack of sufficient repetition on the part of students." She had two rows of pictures of objects with their names at the top. On the back row appears *l'enfant, l'homme, la mère, l'oncle,* and *Robert.* On the front row appears *l'argent, le livre, le papier, la plume,* and *la table.* In one exercise, a pupil moves each object over to the corresponding person and says, "Je donne le livre à l'enfant; je donne le livre à l'homme," and so on. Each of the other pupils repeats the same in turn. In another exercise, each object in the front row is the property of pupils in the back row. One pupil says, "J'ai l'argent de l'enfant; j'ai le livre de l'homme," and so on. The others repeat the same in turn. In another exercise *A* says to *B*, "Montrez-moi l'argent," and *B* replies, "Voici l'argent." In another exercise, *B* is considered to be an owner of the objects. *A* says, "Vous avez l'argent du père." In another exercise *C* is considered to be the owner; then *A* uses his name and the third person singular of the pronoun. In still another exercise, conversation is carried on among the pupils about the objects in question-and-answer fashion.

By methods of this sort, a first-year class was prepared for second-year French in 65 hours instead of the usual

165. The pupils from this class led the second-year class. Among other things, they had learned thoroughly the facts of the first twenty lessons of Fraser and Squair's *New Complete French Grammar,* read more than 150 pages of easy French, acquired a reading vocabulary of about 2,300 words, and a speaking and writing vocabulary varying according to the pupil from 300 to 600 words.

An experiment on the value of free composition. Free composition is one of the features of the direct method. It is "free" in the sense that the pupil does not write a literal translation from the grammar into the foreign language, but rewrites a story in his own style. In testing the value of free composition in French, Cole [27] selected two groups of fifteen boys each out of 120 who had been selected for the French College Entrance Board examination. The boys were chosen on the basis of their I. Q.'s and their work in the College Board examination. Each section had the same teacher and was given assignments in grammar, reading, and certain idioms and verbs. Section I (free composition) was tested by prepared quizzes and given home work in free composition. It also did much paraphrasing of, and written composition on selections read, and exercises of the sort found in Robert's *Exercises on Jettalire* or "close reading." Section 2 (translation) was required to write out the specific exercises of each assignment in grammar and translate the reading selections carefully from French into English. At the end of each semester, each section was tested with the *American Council French Tests,* Experimental Edition, *F*-10, Form *A,* which contains tests for vocabulary, grammar, silent reading, and composition. The College

[27] Cole, Robert D., "Free Composition *vs.* Translation into the Foreign Language in Developing Ability to Write a Foreign Language," *Modern Language Journal,* Vol. XI (1926–27), pp. 200–208.

Board examination was given again, and records were also kept of the teacher's daily marks.

The results demonstrated that the pupils taught by the free-composition method were somewhat superior in ability to do college work, in knowledge of vocabulary, in knowledge of grammar, in silent reading, and in quality of composition. The amount of superiority was not great but there was enough to show that the free-composition method is at least as good as the translation method.

Correspondence with foreigners as method of developing ability in composition and creating an interest in foreign language. In connection with the teaching of composition it is worth while to call attention to the advantages which Miss Mohr [28] found in having her pupils carry on correspondence with pupils in France. She found one correspondent in France for each of her high-school pupils in second-year French, who then wrote a letter in French and one in English. The French correspondents corrected the mistakes in French made by the American pupils, and the American pupils corrected the English mistakes of the French pupils. The wrong sentences were written on one side of the page and corrections on the other, in parallel columns. In addition to a large amount of personal information about themselves and their families, the French correspondents contributed many facts about the interesting places in their towns, holidays, sports, French authors whom they liked, and French composers. The pupils also exchanged many photographs, post cards, and pictures. One of the main effects was an immense increase in interest in the study of French, not only on the part of pupils but also on that of their parents.

[28] Mohr, Wilhelmina, "An Experiment in Correspondence," *Modern Language Journal,* Vol. IV (1919–20), pp. 387–396.

Criticisms and Further Experiments

Our scientific information about methods of teaching foreign language is very limited. Although many experiments have been made, a comparatively small number have a high degree of scientific value. In many of them a number of the rules of scientific experimentation have not been observed. These include: using equivalent groups, having groups using different methods spend the same amount of time on each method, keeping all variables constant except one, translating a given method into a fixed or definite procedure during the period of the experiment, measuring the results of each method objectively and calculating the reliabilities of the differences between the methods used. Nearly every topic discussed in this chapter is in need of further experimentation. The comparative values of the grammar, direct, and mixed methods need to be established under experimental conditions in which the rules of scientific experimentation are more carefully observed. Further experiments are needed to determine comparative value of foreign word-native word associations, and foreign word-object associations; the most economical number of repetitions to give to vocabularies to be learned in list form; the comparative value of learning vocabularies in the list form and in the contextual form; the comparative value of the dictionary method of learning vocabularies and the contextual method; the comparative value of various contextual methods; the extent to which methods found effective for developing speed and comprehension in learning to read the native language are applicable to learning to read a foreign language; the value of using interesting and familiar content; and the value of free composition.

Summary

General methods of teaching modern foreign language are the grammar, the direct, and oral.

The grammar method is characterized by its emphasis on the analytic study of grammar and the use of grammar in translating from the foreign language into the native. The study of pronunciation, vocabularies, inflections, and composition is incidental to these objectives. Its advantages are the following: use of learner's previous language habits, use of adult's powers of analysis, and use of translation as a test of comprehension. Its disadvantages are the following: the emphasis is on the native language; the foreign language is a medium of translation instead of a medium of thought; the thought of the foreign language is hidden until translated; there is no direct association between foreign word and object; the foreign language is not learned in thought units; the use of the foreign language is made a conscious and analytic process, and as a result, speaking or writing it is always slow and laborious.

The direct method is characterized by the maximum use of the foreign language in class; inductive study of grammar; learning of vocabularies by the use of objects, gesture, and explanations in the foreign language; and much reading without translation and free composition. The advantages claimed for it are the following: the foreign language is learned in much the same way as the mother tongue; it is interesting, and direct associations are formed between word and object; grammar and phonetics are learned in relation to their uses in the language; the method is economical, as all work relates directly to the goal; and there is good motivation, as every learner must learn the language in order to under-

stand the work of the classroom. The objections to the method are: that it does not give precise knowledge of vocabulary and grammar; that it requires too little pupil activity in the early stages of learning; that explanations in the foreign language require too much time; that the large amount of time spent on pronunciation is wasted because there is no opportunity to make practical use of this art; that most teachers in America cannot speak the foreign language well enough; and that the classes in American public schools are too large to allow each pupil sufficient practice.

The oral method is characterized by the exclusion of grammar, phonetics, reading, and writing until the hearing and speaking of the language are mastered. The learning during this period is restricted to ear work and makes use of only the spontaneous, unconscious, and habit-forming activities of the learner. It is well adapted to the formation of aural-oral habits, but it does not appear to be an economical method for the acquisition of a reading knowledge by adults.

The claims of each method can be established only by experiments, but as yet an insufficient number have been made.

According to the experiments of Young, a mixed method with emphasis on reading yielded superior results for American students. The essential features of this method were the study of the grammar, the study of irregular verbs, the study of lists of the most frequent words and idioms, the beginning of easy reading during the second week of the course, learning the elements but not the details of pronunciation, ear training in listening to oral reading, and regular use of objective tests.

Experiments on methods of learning vocabularies in list form justify the following procedures:

Forcing recitation of the parts during the learning.

Forming associations between the foreign word and the English equivalent. If possible, the association should be based on meaning.

Spending part of the time of study in the voluntary recall of the English equivalents.

Studying aloud rather than studying aloud with written recall or studying silently.

Forming associations between words and objects, as these are more easily formed and retained than associations between words. This appears to be true at any rate when the purpose is readiness to give a foreign word when an object is presented; but associations between foreign word and native word may be best when the purpose is to give the native equivalent for the foreign word. Schmidt found an exception to this in case of verbs.

It is possible that finding the meanings of words from the context with or without the aid of a dictionary is a more economical procedure than any method of learning vocabularies in the list form. This form of learning brings into play many types of inference that are based on such relationships as similarity, analogy, known to unknown, cause and effect, oppositeness, identity or sameness of meaning, part-whole or whole-part, and time and place. There are, however, no experiments to enable us to form a judgment on the economy of these methods.

Familiar material in the foreign text is useful for increasing speed of reading.

Procedures for increasing speed that may be inferred from experimental studies of how children learn to read their native language are: use of material carefully graded in difficulty, use of interesting material in large quantities, exercises for increasing span of perception and eye-voice span, silent reading with suppression of lip and tongue movements, time-limit tests followed by reproduction of content, and curves of progress showing the amount read from day to day. Special devices that may be used successfully with certain individuals are: choice of selections that appeal to the special interests of the

reader, exercises in recognizing thought units, accurate oral reading of familiar stories, exercises in analyzing and recognizing phonetic elements, exercises in dividing long words into syllables, and practice in making accurate return sweeps.

Some devices that have been used successfully in improving the comprehension of children while they are learning to read their native language may be transferred to learning to read a foreign language.

The so-called laboratory method, which consists of language drills in connection with the manipulation of objects, proved to be an effective method of teaching first-year French, according to Caroline House.

According to an experiment by Cole, free composition yielded slightly higher scores in vocabulary, grammar, and reading than did the traditional methods of composition.

Miss Mohr found correspondence between American and French pupils an effective method of stimulating interest in the study of French.

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CHAPTER 11

Foreign Language: Individual Differences

We have shown the comparative value of various methods of learning and teaching foreign language. We shall now turn to the consideration of achievement in foreign language in relation to individual differences, such as homogeneous grouping, age, grade, sex, nationality, and so on. Our knowledge of the relation of these factors to achievement in foreign language we owe to the use of objective and standardized tests. We have already seen their use in evaluating methods of learning. They are equally useful for the evaluation of special factors. Since nearly all our scientific information about the study of foreign languages is obtained from these tests, it is appropriate at this point to discuss briefly their reliability.

The Reliability of the New-Type and Standardized Tests.

The unreliability of the old-fashioned essay examination is indicated by the findings of Wood [1] that those who failed in this test had about the same range of achievement when measured by new-type objective tests as those who passed, that some of those who failed in the old-type tests were above the median objective achievement of those who passed them, and that some of those who

[1] Wood, Ben D., *New York Experiments with New-Type Modern Language Tests* (Publications of the American and Canadian Committees on Modern Languages, Vol. I). New York: The Macmillan Company, 1927.

passed the old-type tests were below the median objective achievement of those who failed in them. These facts may be seen from Figure 2.

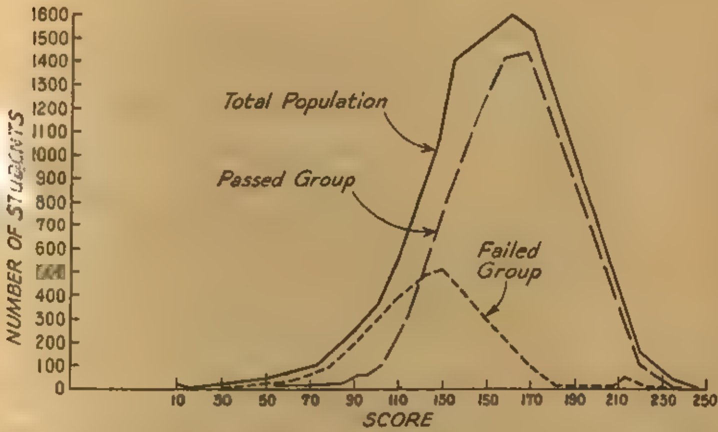

Fig. 2. Graphs of distributions of new-type scores of total population, and of passed and failed groups in French II. The passed and failed groups consist of students passed or failed by the old-type part of the Regents examinations. (From Wood, 1928)

The superiority of the new-type over the old-type examination is indicated by the following facts:

The reliability coefficients between the halves of the tests are from 25 to 65 points higher in the new-type than in the old-type tests.

The coefficients of alienation show that the new-type tests are from 1½ to 2¼ times as reliable as the old-type.

A new-type 90-minute examination exposes the student to at least twice as many different words as a 180-minute old-type examination. Besides, the words in the new-type examination are graded much more accurately in respect to difficulty.

In the old-type 180-minute examination the student has to write about 6,000 running words in order to expose himself to 225 different root words, while in the new-type he has to write only about 175 symbols and 125 words in order to react to 500 different words.

The old-type tests require many more irrelevant activities than the new-type.

Some of the uses of the new-type tests in teaching are: in setting standards of achievements and making possible comparisons between schools; in classification, investigation, diagnosis and remedial treatment; and in determination of specific outcomes.

Individual Differences in Achievement in Foreign Language in Relation to Grade

The differences in achievement in foreign language in relation to grade are very wide. Typical distributions for the Alpha French tests are found in Figure 3, which shows the results for the vocabulary test.[2] The range is so great that the pupils of each semester are distributed over most of the scale, thus making it difficult to see evidence of progress between successive classes. In fact, the overlapping is so great that the lower fourth of the eighth semester classes has no greater achievement than the upper fourth of the first-semester classes. Figure 4 shows the percentile curves for the same facts as in Figure 3, in which the overlapping of the various high-school classes can be seen in another form. If we compare the fourth-semester pupils with those in lower and higher classes we see that about 30 percent of the third-semester, 7 percent of the second-semester, and 2 percent of the first-semester pupils are above the median of the fourth-semester pupils; also that 28 percent of the fifth-semester, 12 percent of the sixth-semester, 9 percent of the seventh-semester, and 3 per cent of the eighth-semester students are below this median.

It is reasonable to suppose that all the pupils from upper classes whose achievement falls above the lower

[2] Henmon, V. A. C., *Achievement Tests in Modern Foreign Languages* (Publications of the American and Canadian Committee on Modern Languages, Vol. V). New York: The Macmillan Company, 1930.

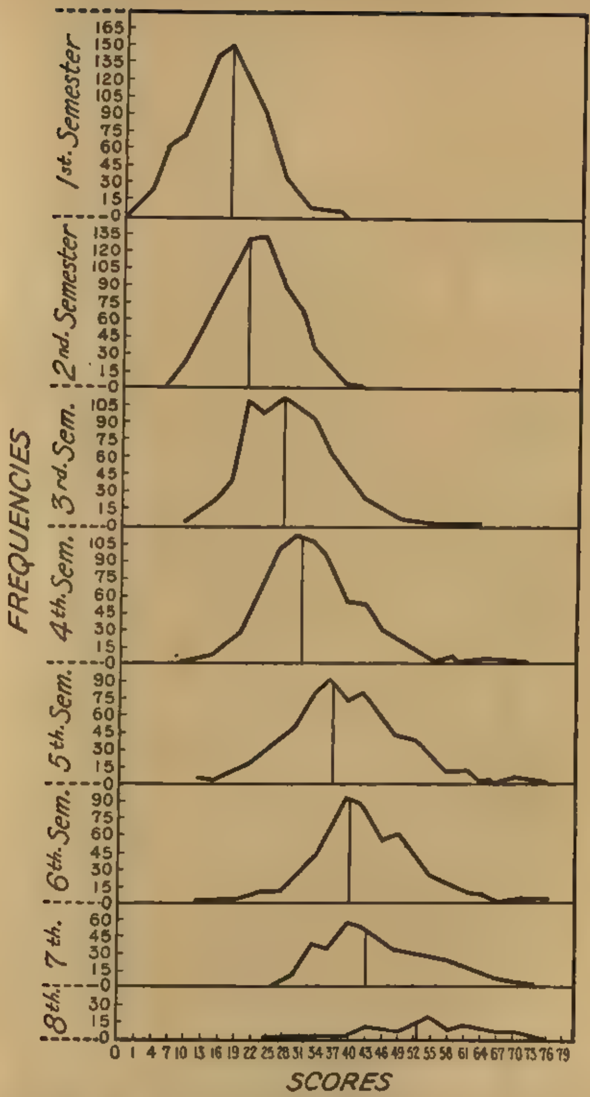

Fig. 3. Distributions of scores in the Alpha French tests (vocabulary), high-school students. (From Henmon, 1930)

quartile of the fourth-semester class, and that all pupils from upper classes whose achievement falls below this upper quartile would be as well fitted for fourth-semester work as the fourth-semester pupils themselves. On this

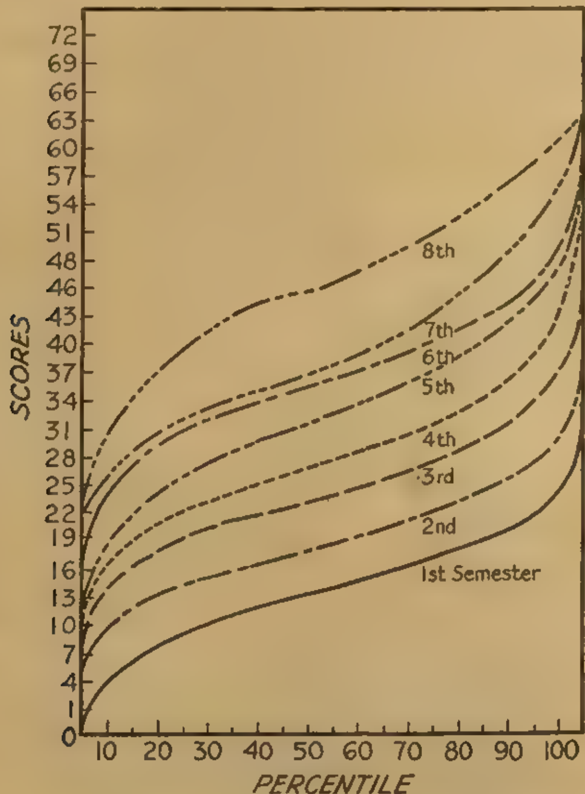

Fig. 4. Percentile curves for French vocabulary in the high schools of the United States. (From Henmon, 1930)

basis, about 55 percent of the third-semester pupils, 25 percent of the second-semester, 7 percent of the first-semester, 50 percent of the fifth-semester, 28 percent of the sixth-semester, 23 percent of the seventh-semester,

and 8 percent of the eighth-semester pupils should be taking fourth-semester work. Similar amounts of overlapping may be found for each of the other classes.

If we turn to the results obtained from the administration of the New-Type Regents Examination to New York high-school pupils, we see a similar situation.

According to Wood[8] more than 60 percent of all French students in New York secondary schools are misplaced by one semester or more. In this calculation, a student is judged to be misplaced when his achievement is nearer to the median of some other class than to that of his own class. Wood also found that over 90 percent of the students in the last three years of high-school French fall within the identical range of achievement.

The important conclusions to be drawn from these facts are: first, that the achievement of the individual has little relation to the amount of time spent in the course. It follows that the custom of giving credit and scholastic degrees upon a time basis is erroneous. Second, the instruction given is adapted to only about 40 percent of the students; consequently a good share of the time of the other 60 percent is wasted. About half of them are pushed beyond their ability, and about half are restrained from working up to capacity. Third, there is a need for adjustment to individual differences. What can be done about it?

Sectioning Classes according to Intelligence Scores

Several experiments have been made on the premise that learning ability is principally a function of intelligence, and that the classification of pupils according to intelligence will go far toward meeting their individual differences. These experiments were made under the

[8] *Op. cit.*

direction of the Modern Foreign Language Study at Lawrenceville, New Jersey, and in the William Penn High School at Philadelphia. In the Lawrenceville experiment, which was directed by Cole,[4] boys from Grades IX and X were divided into sectional and non-sectional classes. The division was made on the basis of the I. Q.'s as determined by the Terman Group Test of Mental Ability and the average mark in French in the previous semester. The experiment was pursued for one semester, at the beginning and end of which the Alpha French tests were given to both the sectioned and the non-sectioned pupils.

The results in Grade IX showed that the sectioned pupils did better than the nonsectioned in the standardized test but received lower examination marks. But here the classes were not equally balanced in intelligence, so no definite conclusions can be drawn. In Grade X, where the classes were more equally balanced, the advantages in the standardized tests were in favor of the nonsectioned classes, although the average examination marks showed a slight disadvantage. Under the conditions, no conclusion can be drawn in favor of ability grouping. Cole held the opinion that the statistical facts do not give a true picture of the situation because of inequalities in the instruction.

The experiment made at the William Penn High School for Girls under the direction of Elizabeth Woods[5] was similar to the one made at Lawrenceville except that the ability groupings were made entirely on teachers' judgments, greater care was taken to equalize teaching ability, and the experiment was continued throughout three semesters. As in the case of the Lawrenceville ex-

[4] Henmon, *loc. cit.*
[5] *Ibid.*

periment, the results were in favor of the mixed groups. Agreeing with Cole, Miss Woods did not believe that the figures gave a true picture of the possibilities of ability grouping. Yet in view of the fact that both experiments agree, it does not seem that grouping according to intelligence or according to teachers' opinions meets the problem of individual differences. The base of grouping used in these experiments was probably too restricted and represented only a few of the many factors which determine the ability to learn French. A more adequate basis of classification would be to combine intelligence, teachers' opinions, and achievement in standardized tests—the heaviest weighting being placed on achievement. If pupils were regrouped at the end of each semester by such a method, the materials of instruction could be adjusted to the needs of students far more adequately. A more suitable pace for learning could also be found for each group.

Sectioning Classes according to Achievement

An experiment showing the value of classification on the basis of achievement tests was made by Tharp,[6] who investigated the reliability of Iowa Placement Tests for this purpose in beginning French and Spanish classes at the University of Illinois. These tests consist of an aptitude test in foreign language and of achievement tests in modern foreign language. The aptitude test is composed of exercises in English grammar and a brief course in Esperanto. The value of this test as a basis of predicting grades was compared with the results of guessing

[6] Tharp, James Burton, "Sectioning in Romance Language Classes at the University of Illinois," *Studies in Modern Language Teaching*, pp. 367–425 (Publications of the American and Canadian Committees on Modern Languages, Vol. XVII). New York: The Macmillan Company, 1930.

grades, an intelligence test, an achievement test in foreign language, and previous grades in foreign language. The predictive value of guessed grades was measured by correlating grades assigned on the basis of the initial letter of the surnames of students with actual grades, while the predictive value of each of the other tests was found by correlating the scores in each test with actual grades at the end of the semester.

It was found that by pure guess 62 percent of the grades could be correctly predicted within one quartile. The predictive value of other tests had to be measured by what they added to this amount. An intelligence test added 5 percent, the Iowa Aptitude added 12 percent, and the Iowa Training added 26 percent. The value of a test for classification depends directly on its predictive value. On this basis, the best test would be an achievement test at the beginning of a semester, but this cannot be given to beginning students. The next best is an aptitude test.

Tharp sectioned classes in French 1A (first semester) on the basis of the Iowa Aptitude Tests. In nine sections those making over 100 in the aptitude test were put in the high sections, while the remainder were put in the middle-low sections. Five sections were left undivided. A similar procedure was followed in Spanish, although the requirement for entrance into the high section of this subject was 110. In French 2A (third semester) one section was composed of students who made *A*, the highest grade, in the previous semester. Another section included those who made *A* and *B* grades. A third section, called "Z" section, consisted only of *D* students. All the other sections were left undivided. In French 1B (second semester), and in French 2B (fourth semester), there was only one special section each, consisting of volunteers

who had won *A* honors in the previous semester's work.

The efficiency of the sectioning was measured first by comparing the average grades in the divided and undivided classes. In calculating this average, an *A* counted as 5, *B* as 4, *C* as 3, *D* as 2, and *E* as 1. A second measure was to compare the grades of students who made *A*, *B*, *C*, and so on, in divided classes, with students making equal initial scores in the aptitude or training tests in the undivided classes. A difference in favor of the divided classes was called excess gain, and its amount measured the value of the grouping. A divided *A* honor class had an average excess gain of 1.26 points over similar students in undivided classes; a divided *A—B* class had an average excess gain of .92 points over similar students in an undivided class, and a divided Z class averaged an excess gain of .82 points over similar students in an undivided class. On the basis of these and similar results, Tharp, convinced that sectioning in foreign languages on basis of ability was valuable and that the greater the homogeneity the greater the gain, concluded that "future majors in the subject may be advanced to the full of their capacity, unhampered by the mediocre, the dullard, and the loafer." The *A* honor sections not only made higher grades but also covered more ground than the undivided sections and had only three fourths of the number of recitations. The results showed also that the variability in achievement was less in the sectioned than in the nonsectioned classes.

Reducing Variability in Achievement in Foreign Language

A great reduction in variability, as well as a higher level of achievement, could probably be attained by a concentration of teaching and study toward a single ob-

jective. So long as the principal aim is merely to cover a certain amount of ground and spend a certain amount of time there will always be a wide scattering in achievement around a low level, as opinions will differ whether the principal objective in language is syntax, inflections, vocabularies, composition, pronunciation, translation, or reading or speaking. But once the teachers and pupils agree that there is a single objective—for example, learning to read—and that there is no credit until that objective is attained, then the scattering of scores from zero to perfection will be reduced, and pupils and teacher will be able to point to something definite that they learned in the language class.

In addition to concentration upon a definite objective, there should be frequent measurement of progress toward the goal. This will not only reveal the points of weakness toward which corrective efforts may be directed, but also supply an effective motive for sustained or increased effort. But if the measurement is to picture real progress, it must be reliable and valid. These characteristics are likely to be found only in an objective test constructed according to approved procedures. Inasmuch as standardized tests cannot usually be given with sufficient frequency for the improvement of teachers' work from week to week, it is important that the teacher of foreign language familiarize himself with the techniques of test construction and the uses of tests.

Variability in achievement will also be reduced by the elimination of those whose progress in learning a language is too slow to make success possible within the time limits of the course. Since it is likely that only the superior student will make any use of foreign language, it is advisable to restrict the election of foreign language to those who are above the average in general scholarship.

Achievement in Foreign Language in Relation to Age

In some public-school systems which have junior high schools, a pupil may begin a foreign language in any grade from the seventh to the twelfth inclusive. If a student goes to college he may begin a foreign language in any year of college, and in many universities courses in beginning foreign language are offered to graduate students. With this amount of choice possible, it is important to know the age or grade at which it is most profitable to begin the study. To answer this question fully we would have to know the relation between the age of beginning and each of the following factors: rate of learning, length of study, degree of final achievement, permanency of interest developed, frequency of use, and rate of forgetting. This information is at present not available, but we do have some results on the relation between age of beginning and rate of learning or achievement after varying lengths of study. The Modern Foreign Language Study has obtained results on this question through studies made by Dr. Li [7] and Mr. D. Sauze.[8] Dr. Li calculated the scores of high-school pupils in tests of French in relation to the grade in which the study was begun and to the number of semesters studied from one to six. He gave the American Council Alpha tests in vocabulary, grammar, and reading.

The effect of the time of beginning the study of French can best be seen by comparing the scores in sixth-semester French of those who began the study in Grade VII with those who began it in Grades IX or X. Their attainment compared favorably with that in fourth-semester French by those who began in Grade IX but

[7] Henmon, *loc. cit.*
[8] *Ibid.*

was not so good as the fourth-semester attainments of those who began in Grade X. That is, those beginning the study in Grade VII required six semesters to learn as much as those beginning it in Grade IX learned in four semesters. In fact, the rate of learning French was increased by each year of postponement beyond Grade VII up to Grade X. The increments gained by postponing beyond Grade IX were not so great as those from Grade VII to IX.

In De Sauze's study, the Alpha French tests were given in Grades VII, VIII, IX, X, and XI to 750 pupils in nine Cleveland high schools at the end of the first semester of French. In addition to the scores from the tests, he calculated the median I. Q. and the median chronological age for each group.

The results showed that the scores of those beginning French in Grade VII were far below those who began it in Grade IX. The differences between the scores of those beginning French in Grade IX and in Grade X or XI were small and for the most part insignificant. Henmon declared that this was due partly to the fact that these classes were mixed, that is, contained pupils from the other classes in high school. But even when allowance was made for this factor the differences were not significant. Although these scores pertain only to the first semester of French they point to the same conclusion as the results of Dr. Li's investigation, namely: that so far as the results of these tests go, it is advantageous to postpone the beginning of the study of foreign language until Grade IX.

This statement is true in particular when a reading knowledge is the principal objective of the study of foreign language. It may be otherwise for those who wish to acquire a speaking knowledge.

The Effect of Beginning the Study of Foreign Language in College

Colleges usually consider two years of high-school work in foreign language the equivalent of one year of college work in that language. This practice is evidently based on the assumption that college students learn languages twice as rapidly as high-school students. It is important to know whether the achievements of the two groups of students are such as to justify this assumption. The Foreign Language Study[9] obtained norms for both high-school and college students through its nation-wide administration of the Alpha tests in French, German, and Spanish.

The results showed that, on the whole, two semesters of high-school work corresponded to one semester of college. This was true of all the tests except those in grammar for the second, third, and fourth semesters of college work, where the two-to-one ratio fell down. In fact, after the first semester the increments in the grammar scores were less for college students in proportion to time than for high-school students. But since this occurred in only one of the four tests it would be insufficient to break down the correspondence established by the other three tests. The doubling of the ability to learn modern foreign language in college students cannot be due to increase in maturity or mental age, for mental-age norms show very little increase beyond the eighteenth year. According to some investigations, mental maturity is reached in the sixteenth year. This great increase in learning ability must be due partly to the factor of selection, partly to the fact that a great deal more is expected of college students than of high-school students, and partly to the fact that the college norms are based

[9] Henmon, *loc. cit.*

on students, some of whom had all their foreign language in college and some of whom had part of it in high school.

The Modern Foreign Language Study tried to isolate the latter factor by giving tests to students who had had only college work in foreign language. They succeeded in finding enough cases to establish medians for the vocabulary, grammar, and silent reading tests for the first and third semesters. It was found that the following norms compared favorably: second-semester high-school vocabulary, 22—with first-semester college, 21; fifth-semester high-school vocabulary, 37—with third-semester college, 36.8; second-semester high-school grammar, 12—with first-semester college, 12.8; fifth-semester high-school reading, 17—with third-semester college, 17.5. The following compared unfavorably: fifth-semester high-school grammar, 29—with third-semester college, 21.7; second-semester high school reading, 9—with first-semester college, 11.6. According to these results the first two semesters of high-school work in French would be equivalent to the first semester of college work, but after that, a ratio of 5 to 2 would more nearly represent the achievements of the two groups. Even this would penalize high-school students in knowledge of grammar.

The comparative achievement of high-school and college students in modern foreign languages was the object of a special investigation by Newly[10] for the Modern Foreign Language Study. He made his investigation among the students of fourteen representative colleges and universities of the Pacific coast states and gave the Iowa Placement Examination, Series F. T., French Training, to 1000 students of French and the Iowa Placement Examination, Series S. T., Spanish Training, to 1500 students in Spanish. The tests provide objective measures

[10] Henmon, *loc. cit.*

of vocabulary, syntax, verb forms, and composition, and allow a total possible score of 166 in Spanish and 170 in French. The students examined fell into three groups: those who had had one year in college, two years in high school, or three years in high school.

In Spanish, the one-year college students were 7 points above two-year high-school students, but 13 points below three-year high-school students. In French, the one-year college students were 5 points below the two-year high-school pupils and 20 points below the three-year high-school pupils.

The results seem to justify the policy of counting two years of high-school work as the equivalent of one year of college work, but they do not justify treating three years of high-school work as equal to a year's college work. While the 2-to-1 ratio may be justifiable as a general policy, it is also certain that this policy should be modified in order to meet the exceptional achievements of individuals.

Norms for American Council Tests in Foreign Language in Relation to Grade and Nationality

Grade norms have been established for high schools and colleges for the American Council tests of French, German, Spanish, and Italian.[11] In the case of Italian, norms have been found for only the vocabulary and grammar tests for high schools, and for the vocabulary, grammar, and silent-reading tests for colleges. These norms are only tentative since they were calculated from a comparatively small number of cases.

Table 8 gives the norms for the Alpha French tests for the high schools of the United States, Canada, and England. The pupils of the United States are considerably

[11] Henmon, *loc. cit.*

superior to those of Canada and England in all the tests except composition, in which England leads. In vocabulary, grammar, and composition the English lead the Canadians but in silent reading the Canadians lead the English. According to Henmon a partial explanation of the superiority of the United States may be found in the fact that in most American high schools the study of modern foreign language is elective, which gives the advantage of selection. Another advantage is that in American high schools foreign-language classes meet five times a week and the study is one of four, whereas in English

TABLE 8

HIGH-SCHOOL NORMS FOR AMERICAN COUNCIL ALPHA FRENCH TESTS FOR UNITED STATES, ENGLAND, AND CANADA

(From Henmon, 1930)

Country	Semester												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Vocabulary													
United States	16	22	27	32	37	41	45	49					
England	15		22		30		39		50		57		63
Canada	14		19		25		34		46				
Grammar													
United States	5	12	19	24	29	33	37	40					
England	5		8		16		23		32		35		39
Canada	5		8		14		23		31				
Silent Reading													
United States	6	9	12	15	17	19	20	21					
England	2		4		8		12		15		17		
Canada	3		6		9		14		19				
Composition													
United States (means)	5.8	6.2	7.3	7.6	8.3	9.0	8.9	8.7					
England	6		8		9		10		12		13		14
Canada	6		6		7		9		10				

and Canadian schools the classes meet only three times a week or less, and the study is one of seven to nine.

The Relation of Achievement in Foreign Language to Special Factors Revealed in Prognosis Tests

The purpose of prognostic tests is to measure the ability to learn a subject and thus eliminate probable failures in advance. Their construction is such as to show the relation of special abilities or other factors to success in the subject. Even if they fail in their ultimate goal, they at least have their value. Why this is true may be seen from their method of construction: first, analyze the abilities and processes which are used in the subject; second, make up tests that measure these factors; third, administer the tests and measure the factors; fourth, have pupils learn the subject until they have reached a measurable achievement; fifth, secure a satisfactory measurement of this achievement which can be used as a criterion of success; sixth, correlate the scores in the prognosis tests with the criterion. The size of these correlations will determine whether or not the prognosis test has any predictive value.

A number of studies have been made for the purpose of finding satisfactory prognostic tests of ability to learn foreign languages. The studies by Odell,[12] Bohan,[13] Symonds,[14] and Van Tassell[15] are typical of the best work

[12] Odell, Chas. W., *Predicting the Scholastic Success of College Freshmen.* Bulletin No. 37, Bureau of Educational Research, University of Illinois, Urbana, 1927.

[13] Bohan, John E., "Relation of Course Marks in English to Course Marks in Foreign Languages and of Both to Intelligence," *Prognosis Tests in the Modern Foreign Languages*, pp. 35–67 (Publications of the American and Canadian Committees on Modern Languages, Vol. XIV). New York: The Macmillan Company, 1929.

[14] Symonds, Percival N., "A Modern Language Prognosis Test." *Ibid.*, pp. 91–129.

[15] Van Tassell, R. J., "The Measurement of Aptitude for Achievement in Foreign Language Study," *Ibid.*, pp. 175–182.

that has been done in this field. The character of the results of these studies may be seen from those obtained by Van Tassell, who used the following tests:

The Terman Group Test of Mental Ability
The Wilkins Prognosis Test in Modern Languages:
- (a) visual-motor (seeing and writing)
- (b) aural-motor (hearing and writing)
- (c) memory
- (d) grammar concepts

The Handschin Predetermination Test:
- (a) seeing-writing
- (b) hearing
- (c) grammar

The Thorndike Test of Word Knowledge.

A special feature of Van Tassell's work was his correlation of the scores in these tests with marks in both French and algebra. The results are given in Table 9.

The interesting feature about these results is that they predict success in algebra just as well as they do in French and that no specific aptitude necessary for success in French is shown which is different from a specific aptitude necessary for success in algebra. In other words, success in learning a language seems to be a function of general ability rather than of specific abilities.

The general interpretation of these studies in foreign-language prognostic tests is that success in learning a foreign language is related in varying degrees to success in other activities. The relationships found so far, however, are not close enough to make prediction of success in language either certain or reliable when applied to the guidance of individuals. The best estimate of the degree of future success in language-learning can be based on success attained in past language-learning. The principal value of the studies which attempted to find prognostic tests for ability to learn a language lies in the relation-

ships shown between success in language and success in other activities.

TABLE 9

CORRELATIONS BETWEEN SCORES IN VARIOUS TESTS AND TEACHERS' MARKS IN FRENCH AND IN ALGEBRA OBTAINED FROM RESULTS IN FIVE HIGH SCHOOLS
(From Van Tassell, 1929)

Test	Marks	
	French (n = 204)	Algebra (n = 96)
Terman Group Test	.399	.462
Wilkins Prognosis Test		
Part 1	.317	.272
Part 2	.229	.295
Part 3	.171	.253
Part 4	.379	.505
Handschin Predetermination Test *B*		
Part 1	.342	.401
Part 2	.426	.357
Part 3	.446	.332
Thorndike Word Knowledge	.538	.433
Artificial Language	.453	.429

Practical Implications of the Study of Individual Differences

One of the most important results of the study of individual differences is our knowledge that achievement in foreign language depends primarily upon the individual and not on length of study, sex, nationality, or even intelligence. In agreement with this fact, credit should be given for actual achievement, and not for length of study or completion of certain courses. For the same reason, the requirements for admission to advanced courses should be based on individual achievement rather than on

previous units or courses completed. The fact that a reading knowledge of a foreign language can be acquired more rapidly when the student is in senior high school or in college than when he is in the lower grades indicates that foreign languages should be taught principally at these levels. It also shows that we should institute similar studies to determine the most appropriate period of life for acquiring a speaking knowledge of a foreign tongue. It may be that the common belief that childhood is the best period is not true. The fact that predictions based on prognostic tests are more accurate than guesses indicates the worth-whileness of further investigations along this line. Progress along each of these lines is dependent upon the wider use of reliable objective tests, which make it possible to base credit on achievement, to determine prerequisites on achievement, to classify pupils effectively, to set attainable goals, and to treat each pupil as an individual.

Possible Reforms in Modern Foreign Language Study

We may fittingly close our study of modern foreign language by quoting from Professor Algernon Coleman,[16] a leading teacher of modern language, who has a scientific knowledge of its problems:

1. Reduce considerably the amount of time devoted to oral work and concentrate on developing a functional knowledge of grammar and the ability to read.
2. Secure the necessary reading experience by requiring considerably more reading outside the classroom than most classes do at present.
3. Adopt an extensive reading course for the majority of students,

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[16] Coleman, Algernon, *The Teaching of Modern Foreign Languages in the United States* (a report prepared for the Modern Foreign Language Study). New York: The Macmillan Company, 1929.

and limit instruction of the present type to those who will continue for more than two years in school or in college.

4. Exclude from modern language classes all but superior students, as determined by high standing in other subjects or by other means.

5. Discontinue the two-year secondary course except in the case of high-school juniors or of other students who have a personal or vocational interest in modern languages and will almost certainly continue in college. For all others demand a three-year period as a minimum.

6. Organize the course of the first two years as a stage during which, for most students, the criterion of success shall be the attainment of ability to read the foreign language in a manner approximating reading ability in the mother tongue, with speaking and writing in the background except as practice in speaking and writing and hearing is an aid in achieving power to read. The general assumptions on which such a course would be based are:

> (a) Only those students who have read a very generous minimum number of pages and who give proof of really being able to read are to be credited as passing.
> (b) Students who have attained this ability will necessarily have acquired considerable knowledge of grammar, through practice in recognition and some analysis, and a good deal of power to understand and to speak within the limits of the class material.
> (c) Those who have successfully learned to read with considerable facility can more effectively acquire in the third year the additional knowledge and the skills they will need to qualify for the next stage.

Summary

Information about the relation of achievement to individual differences is obtained principally from the use of objective tests, which according to scientific investigations, have far greater reliability than the old-fashioned essay examinations.

An idea of the amount of overlapping in achievement in modern foreign language may be formed from such facts as the following:

According to Henmon, if we put those high-school students of French whose achievement falls within the interquartile range of the fourth-semester French into one group, it would include:

7 percent of the first-semester pupils
25 percent of the second-semester pupils
55 percent of the third-semester pupils
50 percent of the fourth-semester pupils
50 percent of the fifth-semester pupils
28 percent of the sixth-semester pupils
8 percent of the eighth-semester pupils

Wood found similar results in the high schools of New York.

From this it follows that the time spent by a student in studying French has little relation to his achievement, that credit given on this basis is erroneous, that the instruction is adapted to only about 40 percent of the pupils, and that the time of much of the remainder is largely wasted.

Classification on the basis of intelligence score or teacher's judgment of ability does not appear to increase the achievement of the pupils.

Classification on the basis of a composite score derived from teacher's judgment, intelligence, and achievement in objective tests—with heaviest weighting on the last—should be tried as a means of reducing variability and improving instruction.

Classification on basis of aptitude or achievement tests, or previous grades in foreign language has been found to be profitable, and the greater the homogeneity the greater the gain.

Concentration of study and teaching toward a single objective, with frequent measurement of progress toward the goal and withholding of credit until the goal is reached, is recommended.

It is probable that the restriction of the election of foreign language to those whose general scholarship is high enough to give promise of ability to profit from its study would also reduce the variability.

There is rapid increase in ability to learn French, as

measured by present tests, from Grade VII to Grade X, after which the increments are small. The increase is such that a seventh-grade pupil requires six semesters to reach the same achievement that a ninth-grade pupil will reach in four semesters. Because of this fact it is advisable to postpone the beginning of the study of French until the ninth grade. This is true at any rate when a reading knowledge is the major objective of studying the language.

The ability of college students to learn French or another foreign language is just about twice as great as that of high-school students. This great increase is due to selection and heavier assignments rather than to maturity. On the whole, this justifies the policy of colleges which count two years of high-school work in French as the equivalent of one year of college work, but it is equally true that it allows no adjustment for exceptional achievement.

Achievement in foreign language increases in relation to grade and is also related to nationality. Americans are superior to the English and Canadians in reading, vocabulary, and grammar, while the English are superior in composition.

The use of prognostic tests in foreign language reveals varying degrees of relationship between language-learning and other activities. Their use is justifiable for the classification and guidance of groups, but the tests are not sufficiently accurate for individual guidance. The best practical index of future success in the study of foreign language is past success in that activity. A practical conclusion from the study of individual differences is the importance of treating each pupil on the basis of his individual achievement. An important aid to the latter is the wider use of reliable objective tests.

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CHAPTER 12

Typewriting: Course of Improvement

Typewriting is an important linguistic activity of secondary-school pupils and as such should be discussed as one of the subjects in the field of language. It is the successor to handwriting and has the same values—to record and communicate thought. Its advantage lies in its speed, both in writing and in reading. Since it has been in the curriculum only a few years, it has not yet acquired cultural and disciplinary values, so we are relieved of the obligation to review the wordy speculations of educational philosophers on values and objectives. Our problems are reduced to the study of the course of improvement in acquiring speed in typewriting, the processes by which it is learned, the most effective methods of developing it, and the tests by which it is proposed to measure typewriting abilities and predict success from such measures. The course of improvement in typewriting is typical of that in learning other school subjects, and is worth knowing on this account. Such information enables the teacher to understand the ups and downs of high-school pupils in their various achievements and develops a sympathetic attitude toward their irregular and often painfully slow progress. Typewriting also illustrates better than any other school subject the fundamental principle of practice as an aid to learning, and the various methods by which its efficiency may be increased. Educationally, typewriting may not be the most impor-

tant subject, but psychologically it is very important, for it reveals so much about the processes of habit-formation.

The Course of Improvement in Typewriting

One of the most interesting features of learning typewriting is the course of improvement, as shown in the learning curve for this activity. When plotted on the basis of amount of work per unit of time, it has the characteristic shape shown in Figure 5, which presents a curve based on the averages of twenty high-school students who had completed 180 hours of practice.[1] There is a rapid and steady progress for the first 90 hours, after which there is an abrupt slowing down of the rate of learning and presumably a slow approach to the limit of improvement. Although averages represent central tendencies, they do not show the actual record of any one individual. Actual records of individuals, however, are shown in the curves for subjects *B*, *M*, and *E*, which are noticeably different from each other and from the average. Like the average curve they show rapid initial progress followed by slow progress, but unlike it, their progress is very irregular. *B* is a much more rapid learner than *M*. He goes over the 200-line at the end of 82 hours, but *M* does not reach it until the 180th hour. *B* also shows positive acceleration for the first 60 hours—that is, his amount of gain per day increases from day to day. *M*, on the other hand, shows negative acceleration throughout—that is, his amount of gain per day decreases from day to day. Both, however, strike plateaus, or periods of no progress, at the same time: *B* at 116 hours, when he is writing 261 words in five minutes; and *M* at 116

[1] Chapman, J. Crosby, "The Learning Curve in Typewriting," *Journal of Applied Psychology*, Vol. III (1919), pp. 252–268.

hours, when he is writing 187 words in five minutes. *B* overcomes his plateau at 164 hours, when he writes 267 words in five minutes; and *M* at 178 hours, when he

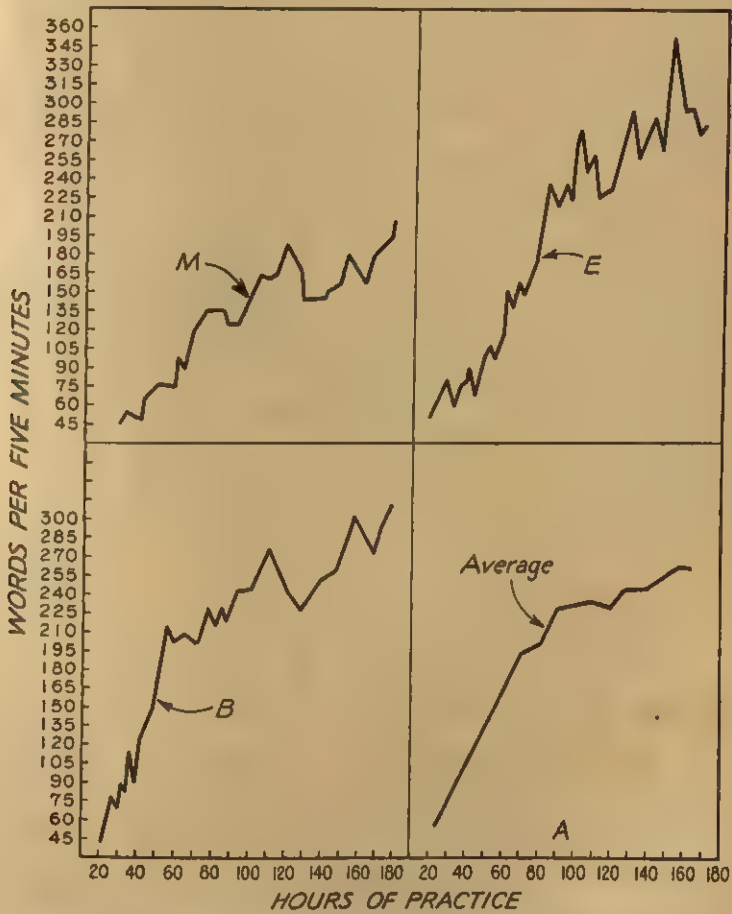

Fig. 5. Curves of progress in typewriting, for subjects *M*, *E*, *B*, and for average *A*, of 22 subjects. (From Chapman, 1919)

writes 199 words in five minutes. The appearance of the plateau at 116 hours was, however, a mere coincidence. It usually does not appear after any given amount of

practice. In the case of two other subjects used in this experiment, it appeared for one at 86 hours, when he was writing 222 words in five minutes; while for the other it appeared at 144 hours, when he was writing 245 words in five minutes.

Since the curves in Figure 5 represent but 180 hours of practice, they do not show the course of progress up to the limit of improvement. We may assume this because of the fact that school champions have written as many as 400 words in five minutes, while professional champions have written as many as 730 words in five minutes. The curve of improvement for the second period of 180 hours may be presumed to rise more slowly, alternating between plateaus and rises. This, however, would not be the case in a curve based on the averages for many individuals. The average results up to 30 months or 600 hours of instruction, are shown in Table 10, which is based on the Blackstone norms.[2]

TABLE 10

NORMS FOR BLACKSTONE STENOGRAPHIC PROFICIENCY TESTS IN RELATION TO MONTHS OF INSTRUCTION

Months	5	10	15	20	25	30
Norm	88	148	178	200	220	236

In this case, the score equals:

$$\frac{\text{strokes per minute times ten}}{\text{number of errors plus ten}}$$

The norms are calculated from 2,188 cases, and represent attainable scores for high-school pupils. A month of instruction means twenty recitations of forty-five minutes each—one for each school day. The curve shows

[2] Blackstone, E. G., *Blackstone Stenographic Proficiency Tests.* Yonkers, New York: World Book Company, 1923.

rapid progress up to ten months, or 200 hours, and then a slow and rather steady progress. But this curve is difficult to interpret because we cannot translate the scores into units of work done by the pupil, such as words per minute. For example, if a pupil wrote 100 words per minute and made ten errors, his score, counting a word as five strokes according to Blackstone's formula, would be only 250, but if he made no errors it would be 500. The Blackstone norms can be translated into units of work only when the pupil ceases to make errors; before that, the work done correctly is so severely penalized that the norms do not give an accurate picture of the course of improvement—if by improvement we mean increase of amount of work done correctly per unit of time.

We may summarize the main features of the course of improvement in typewriting by saying that it is characterized by an initial period of rapid but irregular progress, followed by periods of slow or no progress interrupted by rises and falls until the limit of improvement is reached.

Changes in the Learner While Acquiring Skill in Typewriting

The course of improvement in typewriting is brought about or accompanied by changes in the learner. We shall now describe the most important of them. The principal study of this phase of learning was made by W. F. Book [3] and three graduate students, *X*, *Y* and *Z*, who made elaborate introspective reports on the conscious processes that occurred while learning. These reports, although subject to many errors, give a fair idea of

[3] Book, William F., *The Psychology of Skill with Special Reference to Its Acquisition in Typewriting*. University of Montana Studies in Psychology, Psychology Series I, 1908 (republished by Gregg Publishing Company, New York, 1925); also, *Learning to Typewrite*. New York: Gregg Publishing Company, 1925.

the changes in the learner. Progress was measured by the number of strokes in the first ten minutes. The curves of progress for *X's* practice with new copy by the sight method, *X's* practice with new copy by the touch method, and *Z's* practice with new copy by the sight method are shown in Figure 6.

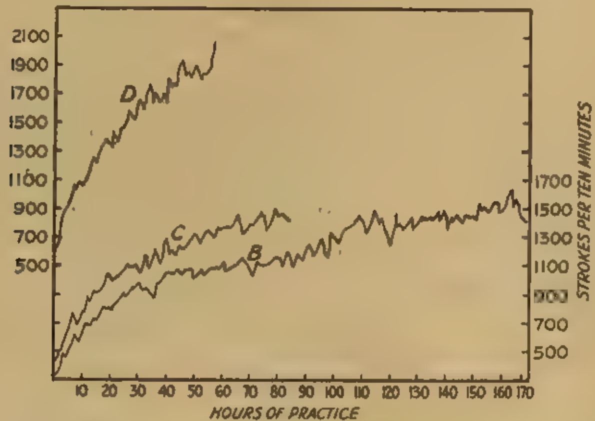

Fig. 6. Progress curves in typewriting. Curve B-*X's* regular sight-method practice. Curve C-*Z's* regular sight-method practice. Curve D-*X's* regular touch-method practice. (From Book, 1908)

Three Stages in Learning Typewriting

In describing the processes that were used during the course of practice from which the above curves were obtained, Book distinguishes three stages of learning: (1) *the letter stage;* (2) *the syllable and word stage;* and (3) *the expert stage.* The letter stage is concerned with writing letters; the syllable and word stage with writing of syllables and words by continuous movements; and the expert stage with writing one or more sentences by continuous movements.

The letter stage. The letter stage involved five steps: (1) getting the copy; (2) actually spelling or thinking of

each letter to be made; (3) locating it mentally on the keyboard; (4) getting the proper finger on the key; and (5) pronouncing the letter again or initiating the final letter-making movement. Locating a key mentally and getting the proper finger on it were rather elaborate processes in the early stages. The learners first memorized the keyboard. *Y* learned it so well that he could draw it correctly from visual memory. In writing a letter, he first got a visual image of its correct position and then moved his finger in the proper direction. *X*, however, made a map of the keyboard and then located the keys with reference to it. In finding the keys, the little fingers were constantly kept on "home" position—the *a* and *;* keys. If a certain key was sought, its row would first be located, then each key felt until the one sought was found. For example, if *t* was wanted the learner would go to the row above his little finger and with the other three fingers of his left hand feel each key separately, noting as he raised his fingers, *q*, *w*, *e*, *r*, and then *t*. In the course of practice, all these steps dropped out, so that the sight of a letter led directly to striking its key. In this short-circuiting process, an important factor was the rise of the so-called motor-tactual "feel" of the letter-making movements. This, when provoked by the sight of the letter, gave the cue to striking the proper key, the correctness of which was checked by the resulting touch sensation. The motor-tactual feel was easily forgotten, but its fading, when everything went well, was a symptom of the perfection of the letter-key associations and of the beginning of the syllable and word stage.

The syllable and word stage. In the syllable and word stage the copy was read in units of syllables and words. Inner speech or mental spelling reappeared and was said to initiate and control the writing movements, but it be-

came more and more infrequent and yielded to a characteristic pronunciation of the word as a whole. There followed a sort of "group spelling" in which little attention was given to individual letters and movements. The keys were located by recognizing the positions of the fingers at the start. Then a rapid series of movements was made until a point of difficulty was reached, when another orientation was made. Errors were individually recognized when made. Then the motor-tactual feel changed from the individual movements to group movements, and attention was directed either to the succession of movements, to irrelevant matters, or to higher forms of control constituting the expert stage, for which the learner was as yet unprepared.

The expert stage. In the expert stage the writing was continuous and "group spelling" was replaced by pronouncing the words. The reading was a number of words ahead of the hands, and attention was directed to pronouncing, to the succession of movements, and to keeping track of the hands. Words, phrases, and clauses were now reacted to as wholes, and called up a semi-conscious feeling of the necessary movements at sight. This was all that the copy meant to the writer. One serious difficulty, however, was to prevent the wrong series of letters in familiar words. For example, in writing *this, th* was apt to be followed by *e* instead of by *is* unless careful attention was given to sequence. The ever-present possibility of such interference required a high degree of attention while writing.

Temporal Sequence of the Learning Stages

The letter, word, and expert stages had a temporal sequence that corresponded somewhat to the order stated, but there was no definite point where one ended and the

other began. On the contrary, there was a wide overlapping. The three stages may even develop simultaneously. The emphasis at first was on letters, but while some of them required individual attention, others fell into word groups, resulting in the formation of some phrase habits before all the letter associations were perfected. Then there was a period in which the emphasis was on words, followed by another period in which phrases and sentences were emphasized. Since there was no definite temporal sequence for these stages of learning, we cannot associate them with definite parts of the learning curve. We can, however, associate the letter and expert stages with the beginning and end of the curve, respectively, and the word stage with the part of the curve between them, but without indicating the amount of overlapping.

Reasons for the Shape and Irregularities in the Curve

There are three characteristics of the curve to be explained here: the general shape, the variations from day to day, and the plateaus.

The general shape of the curve may be described as convex upward with respect to the vertical, that is the curve rises rapidly and then turns toward the horizontal. The turning is partly the result of the basis of plotting—amount of work per unit of time. The amount of work depends on the number of motions, and since there is a definite limit to the speed of motion, the curve becomes horizontal as soon as this limit is reached. At first the errors are numerous but diminish rapidly. There is much room for improvement. The movements are simple and often familiar, and interest and effort are great. These conditions produce an abrupt rise in the curve. The

fundamental cause of the upward trend, however, is practice, by which is meant not the mere exercise of a function, but exercise by a learner who has a definite goal in mind, who has knowledge of his approach to that goal, who knows when he is right and when he is wrong, and who has some knowledge of what to do to correct his errors.

The variations in production from day to day are due partly to external conditions, such as new or long words

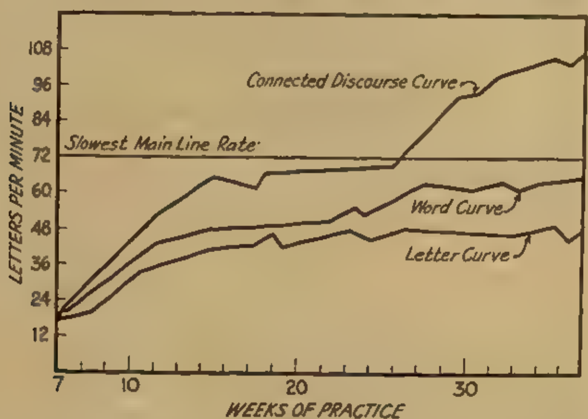

Fig. 7. Curves of progress in receiving the telegraphic language. (From Bryan and Harter, 1899)

in the copy, changes in light and temperature, and occurrence of distractions, and partly to internal conditions, such as changes in attention, effort, interest, health, amount of rest, methods of work, and habits of living. Since one's amount of available energy is always a variable quantity, we should expect a corresponding variation in the output. These factors, however, do not account for plateaus—the relatively long periods of no progress.

According to Book an important cause of plateaus is

lack of effort and interest. Objective evidence of this was found in the fact that the pulse was accelerated less above normal during a plateau than during a rise in the curve. The observations of the learners confirmed the lack of interest. But it is a matter of doubt whether lack of interest is cause or effect. Failure to make progress might easily lead to reduced effort and interest. On the other hand, if a learner simply relaxed, the curve would certainly fall or stay at a level.

Studies made of other kinds of learning lead us to believe that a fundamental cause of plateaus is the prevalence of imperfect elementary habits. This was first demonstrated by Bryan and Harter's[4] studies in learning telegraphy and was confirmed by studies in motor learning by Batson.[5] In one part of the study by Bryan and Harter, three kinds of copy were used in learning to receive the telegraphic code: letters that did not make words, letters that made words but not sentences, and letters that made sentences. Figure 7 shows the resulting curves. It will be seen that all three curves have a rapid initial rise followed by a long plateau. After this, the sentence curve has a second rapid ascent while the word curves and letter curves have small rises to final levels. The second ascent in the sentence curve came just at the time when word and letter habits had reached a stage of perfection. The assumption is, therefore, that it did not occur earlier because the letter and word habits had not been automatized. Batson's experiments showed that plateaus occur in habits involving the coördination of a number of factors. In one of his experiments the sub-

[4] Bryan, William L. and Harter, Noble, "Studies in Psychology and Physiology of the Telegraphic Language." *Psychological Review,* Vol. IV (1897), pp. 27–53; Vol. V (1899). pp. 345–375.

[5] Batson, W. H., "The Acquisition of Skill," *Psychological Monographs,* Vol. XXI, No. 91, 1916

ject was required to pick with a pair of tongs a shot from a pocket in one revolving disk and throw it into a pocket in another revolving disk. The task required four operations: (1) hitting the shot; (2) grasping it with the tongs; (3) hitting the second revolving disk with the shot, and (4) hitting the pocket within this disk. Here it is easily seen that success in the fourth operation depends upon efficiency in the other three. Curves of progress were plotted for each operation for each of four subjects used in the experiment. In all cases, the curves for the first operation came to a level first and were followed, in order, by the curves for operations 2, 3, and 4. There was a plateau in the curve for operation 4 before the curves for operations 2 and 3 came to a final level, indicating that a plateau in a complex habit is caused by lack of efficiency in its elements.

Another important cause of plateaus is lack of incentive. There are records of persons who performed some skilled work for twenty years or more and then had a sudden rise in their output because of a new incentive, such as better pay. When new incentives together with intense effort yield no further gain, we may assume that nature has reached its limit. In addition to lack of effort, lack of interest, and lack of perfection in elementary habits, the experience of most teachers would cause them to accept other reasons for plateaus for which we have little experimental evidence. These include cramming, physical defects, malnutrition, too much social life, loneliness, too much outside work, unhygienic living, and unhappy home. Since nearly all these can be remedied, a plateau always presents a problem, diagnosis of which, because of its numerous possible causes, requires intimate and detailed knowledge of the learner as an individual. Often, however, the only remedy is sustained practice, but sometimes a rest of a week or two is more helpful.

Summary

The values of typewriting are speed and accuracy in the recording and communication of thought.

The subject of typewriting is of general interest to all students of education because it illustrates so well the course of improvement in learning, and a number of factors that influence the rate of learning. The word *improvement* is used as meaning *increase in the amount of work done correctly per unit of time.*

The main characteristics of the learning curve in typewriting, when plotted on the basis of amount of work per unit of time, are: rapid initial rise with a tendency toward positive acceleration in its early period, an approach to the horizontal as the limit of improvement is reached, irregular progress from day to day, and periods of no progress, or plateaus, alternating between periods of progress.

The principal changes in the learner which go on while the habit is in formation are: attention to letters, attention to syllables and words, and attention to phrases and sentences.

Learning the letters involves five steps: (1) getting the copy; (2) an actual spelling or thinking of each letter to be made; (3) locating it mentally on the keyboard; (4) getting the proper finger on the key; and (5) pronouncing the letter again and initiating the final letter-making movement.

The learning of syllables and words is characterized by receiving the copy in units of syllables and words, spelling them mentally, changing gradually to pronouncing them, and withdrawing attention from individual movements and directing it to their succession and grouping.

The learning of phrases and sentences is characterized

by receiving the copy in units of phrases and sentences, pronouncing the words, reading the copy some distance ahead of the writing, directing attention to the succession of movements, and writing phrases and sentences as continuous series of movements.

The letter, word, and sentence stages of learning occur in the order named but with wide overlappings.

Since the curve for typewriting rises in relation to the amount of practice, the fundamental cause of improvement is practice, that is, exercise of the function with knowledge of the goal, knowledge of the approach to the goal, knowledge of right and wrong reactions, and knowledge of the way to correct errors. In addition there are special causes operating at various times. In the early period, concentration is on the elimination of errors, while in the late period, it is on the combining of elementary habits into higher units.

The irregular daily progress is caused, in part, by fluctuation in the energy of the learner, and in part, by unequal difficulties in the learning material.

Plateaus are caused by imperfect elementary habits, lack of effort and interest, and lack of ability. We have experimental evidence of these causes but in the opinion of teachers, there are a number of others: lack of incentive, cramming, physical defects, malnutrition, illness, too much outside work, too much or too little society, unhappy home, and unhygienic living.

All these causes except lack of ability can be remedied and, therefore, present problems for diagnosis or "case study."

CHAPTER 13

Typewriting: Methods of Practice and Individual Differences

Intense effort. The higher levels in typewriting are reached through mastery of the lower units such as letters and words, and through the acquisition of such higher units as the ability to write a long sentence in a continuous series of movements. This implies ability to read the copy ahead of the writing, and to prepare the writing movements in advance of their occurrence. That is, the preparation of one set of movements overlaps the writing of another set. Book sought to discover the methods which learners used to forge ahead to higher levels. He found that better methods occurred unconsciously, and that they occurred when the learner was feeling well and putting forth intense effort. Accordingly we can do two things to increase the rate of learning: maintain good health and practice with intense effort. But, in addition to this, there are some methods of learning which lead to more rapid progress than others, such as learning by the touch rather than by the sight method, distributing the practice, using effective motivation, practicing what one sets out to learn, and centering attention upon the correction of errors.

The Touch Versus the Sight Method

In learning a skill it is always a good principle to try to accomplish an objective in the simplest and fewest possible movements. In line with this principle we

should expect the touch method to be superior to the sight method because it requires fewer movements. The sight method, however, has at least one advantage: it makes possible a quick and accurate location of the keys at the beginning. Its disadvantage lies in the effort required to memorize the copy and to shift the eyes back and forth between copy and keyboard. These are the source of many errors and consume time. Besides, the shifting is fatiguing. An idea of the relative speed of the two methods may be obtained from the results of a subject *X* in Book's study, who learned typewriting by each method.

The touch method was 36 strokes per minute more rapid. This is equivalent to about 7 words per minute or 420 words per hour. The difference, although very great, is not reliable, however, as it is obtained from only one subject and may therefore deviate widely from the average. Since the touch method followed the sight method, it may have benefited much from the previous practice. If the order of practice had been reversed, the results might have favored the sight method, although this is unlikely.

Distributed Practice

Distributed practice is better than concentrated practice for developing skill. Its effect in typewriting was studied in an experiment by Pyle,[1] who had each of two groups of adults practice for a total of forty-five hours. Group I practiced ten half-hours a day for nine days, while Group II practiced two half-hours a day for forty-five days. Each group had a half-hour's rest between practice periods. Improvement was measured by the

[1] Pyle, William H., "Concentrated versus Distributed Practice," *Journal of Educational Psychology*, Vol. V (1914), pp. 246–259.

number of words written per half-hour. At the end of five hours of practice, Group I had a speed of 233 words, and at the end of forty-five hours, a speed of 596 words. The corresponding scores for Group II were 285 and 729 words, respectively. Each group made large gains, but the group which had learned by distributed practice wrote, at the end of practice, an average of 123 more words per half-hour than the group which had had concentrated practice. This amounts to a superiority of about 20 percent.

These results are in agreement with similar experiments in other forms of motor learning, and show that, as a rule, the more distributed the practice, the more rapid the improvement. But there are limits, for the sittings may be too far apart as well as too close together, or they may be either too long or too short. This rule has an application to the length of the practice periods in schools using single or double periods for typewriting. Pyle's experiment suggests a preference for the single period. That this inference is justified was shown in an experiment carried out in the schools of St. Louis by H. H. Davis,[2] and also in an investigation made by Bessie A. Young.[3] Davis compared the gains from single and double periods for four terms. The results were measured by the Blackstone Test 4. At the end of the fourth term, the single-period classes made an average score of 209.14, while the double-period classes averaged 221.70.

The advantage of the double period amounts to slightly less than two words per minute. It is doubtful whether

[2] Davis, H. H., "Measurement in Commercial Education in the St. Louis Schools," *Monographs in Education,* First Series, No. 7. University of Iowa, 1926, pp. 42–52.

[3] Young, Bessie A., "The Relative Efficiency of Single and Double Period Typewriting," *Research Studies in Commercial Education,* Vol. V. Iowa City, Iowa, University of Iowa, 1932, pp. 134–149.

this is a sufficient return for the additional daily hour which could have been used for the pursuit of another subject.

Miss Young, in her investigation, made up a test of various phases of typewriting and sent it to a number of schools to be taken by those who were finishing the first year of typewriting. Replies were received from 75 schools using the single period and from 20 schools using the double period. These schools represented 23 states and a total enrollment of 3,300 students. The test consisted of nine parts, and had part tests on speed and accuracy; accuracy; rough correcting; grammatical and typographical errors; identification of parts of the typewriter; identification test on making characters not on the keyboard, as well as some on the keyboard; syllabification; copying, computing, and tabulating; and invoice. True-false and multiple-response tests of information and D. D. Lessenberry's Letter-Writing Test were also given. The composite scores on all these tests were 38.7 for the single-period groups and 37.5 for the double-period groups, demonstrating that there is no advantage in the double period.

Improvement Through Motivation

The rate of learning may be increased through proper motivation. If a learner has a strong motive, he will put forth more effort, keep a sharper lookout for methods of improvement, be more careful to avoid errors and make the proper movements, and better remember successful attacks. Typewriting, like other subjects, may be motivated by a record of progress, contests, praise by the teachers, awards, knowledge of errors and of improvement through subsequent corrective practice, and by the use of the Dictaphone method.

The last two devices have proved very successful in typewriting. They are used as described below.

Motivation by diagnosis of errors and corrective practice. The writer and G. Gatschet made an experiment in teaching typewriting, the purpose of which was to find out whether diagnosis of errors and the use of subsequent corrective practice would increase the rate of learning. Two classes in typewriting were taught by identical methods for the first twelve weeks. At the beginning of the thirteenth week, one class became the experimental group and the other the control group. In the experimental group, each student made a record of the number of words written and of the errors made during each class period. The first work in his next lesson was to write ten lines of each word in which he had made an error in the previous lesson, after which he took up his regular assignment. A tabulation of errors of the class showed that they were the same in number and kind as those found by D. H. Lessenberry.[4] Therefore, for the second semester, five minutes of each lesson were devoted to Lessenberry's *Corrective Drills.* Following this exercise, the student had his corrective practice on the errors of the previous lesson and then his regular assignment. Beginning March 3, the experimental class was given two tests each week in typewriting new material for fifteen successive minutes. The pupils were given their scores on speed and accuracy the following day. The control group was given the same test once every two weeks, but the scores were withheld from the pupils. In addition to motivation by knowledge of results, the Awards Plan of the Remington Typewriter Company was used for the experimental class. This includes awards that vary from

[4] Lessenberry, D. H., *Error Chart.* Syracuse, N. Y.: L. C. Smith and Corona Typewriters, Inc.

a certificate to a portable typewriter, according to the speed and accuracy attained by the pupil. There were also an honor roll and awards of special privileges, for example, an airplane ride, for the pupil who made the best score each month. A barograph showing the number of assignments completed was kept for the members of each class. This and the requirement to turn in perfect copies were the principal types of motivation received by the control class.

When the results from the two classes had been studied, it was discovered that the experimental class had a higher initial average performance than the control class. In order to have balanced groups, the students were paired on the basis of a composite score for the nine weeks previous to the beginning of the experiment. This consisted of the total number of strokes in the completed exercises with the penalty of a fifty-stroke deduction for each error. Nine pairs of students were found who matched each other on this basis. The averages obtained for these two groups were used to evaluate the experimental methods.

The results are given in Table 11. They are derived from fifteen-minute tests given to both classes every two weeks on the same day from March 5 to May 13. The scores represent the percent of accuracy plus the net number of words per minute computed according to the International Typewriting Contest rules.

Although the number of cases is too small to have much statistical reliability, yet the differences between the two classes are so large that the types of motivation used here are certainly worthy of further trial. Since similar procedures have proved to be effective in arithmetic, English composition, and spelling, we may safely conclude that they are equally effective in typewriting. If a pupil

is informed of his mistakes, taught what to do to correct them, and is given an accurate report of his progress, it is reasonable to believe that he has the important conditions necessary for effective learning.

TABLE 11

EFFECTS OF MOTIVATION BY KNOWLEDGE OF RESULTS, DIAGNOSIS, AND OTHER INCENTIVES ON IMPROVEMENT IN LEARNING TYPEWRITING

Experimental Pupils	Score						
	Mar. 5	Mar. 18	Apr. 10	Apr. 17	Apr. 24	May 6	May 13
Average....	113.6	108.7	117.0	115.0	110.6	110.6	101.3
S.D........	21.1	15.2	14.6	12.7	22.14	16.1	14.0
Control Pupils							
Average....	77.3	73.9	70.9	97.4	82.6	72.7	89.9
S.D........	28.4	21.4	32.7	17.9	23.5	27.4	26.9
Difference..	36.3	34.8	46.1	17.6	28.0	37.9	11.4
S.D. Diff....	12.4	9.1	12.6	7.2	12.2	11.7	11.0

Motivation by means of the Dictaphone. The Dictaphone has been found to be a useful instrument for motivating the learning of typewriting. The records may be adjusted in speed to accommodate the rate of any learner. The copy may be given a little more rapidly than he likes to take it, thus stimulating a maximum effort on his part in order to keep up with the machine. The use of the Dictaphone is the essential characteristic of the Miller Method of teaching typewriting. It was devised by Charles Miller of the Miller Institute of Shorthand and Typewriting. According to this method the student starts to learn the keyboard by the visual method, then transfers to the touch system as soon as he is sure of the location of the keys. This way of starting is supposed to

give the learner accurate images by which to direct his fingers. An incentive for speed is provided the learner in exercises on the Dictaphone, which may vary from 10 to 60 words a minute. When a student reaches a plateau he is advanced for a time to a more rapid record than he is able to follow, then returned to a slower record. Perfect accuracy is not demanded at the beginning but an accuracy sheet is kept, upon which appears a complete record of the student's errors.

Experiments on the effectiveness of this method were made by Pearson [5] and Marik.[6] In the first of his two experiments, Pearson used a group of 37 high-school freshmen and divided them, according to his judgment, into two equal classes: an experimental class, which was taught according to the Miller method, and a control class, taught according to the traditional method. Both classes were taught by the same teacher for one semester and were given the Blackstone tests each week. To test the equality of the classes Pearson gave them a group intelligence test, calculated their average chronological ages, and their average number of years of academic training. The curves of the results are given in Figure 8.

The classes did not match well in age and intelligence, but since these factors have a low correlation with typewriting, the differences are not significant. The difference in academic training may have some significance but hardly enough to invalidate the superiority of the Dicta-

[5] Pearson, David C., "An Experiment with the Miller Dictaphone Method of Teaching Typewriting," *Research Studies in Commercial Education*, Vol. I. Iowa City, Iowa, University of Iowa, 1926; also "An Experiment with Automatization of the 1,000 Commonest Words in Typewriting," *Ibid.*, Vol. II, pp. 84–98, 1928.

[6] Marik, Marie E., *A Comparative Study of the Dictaphone Method and the Traditional Method of Learning Typewriting.* Master's thesis, New York University, 1929.

phone method. This is shown in the curves and described by Pearson as follows:

> The traditional class *xxx* climbed from an average of 31 on the first test to an average of 93 on the highest test, a climb of 62 points; the Dictaphone class progressed from an average of 35 on the first test to an average of 136 points on the highest test, a difference of 101 points. Subtracting the 62 point gain of the traditional class from the 101 gain of the Dictaphone class gives a difference of 39 points or about 63 percent.

In his second experiment, Pearson used the Miller Dictaphone Method in connection with two kinds of copy. One group used the traditional copy which began with meaningless letter combinations, then gradually

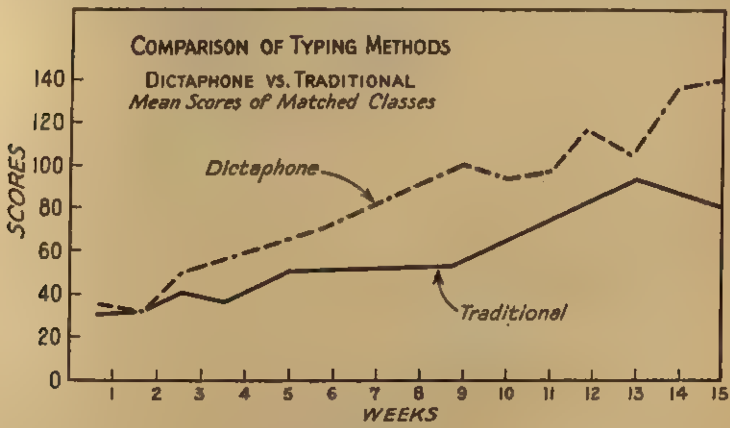

Fig. 8. Motivation by Dictaphone method. (From Pearson, 1926)

changed to sentences. The other group used meaningful material made from the Ayres list of 1,000 commonest words used in business correspondence. The two groups were balanced for intelligence, age, and training. At the end of the semester, the group that had used the meaningful material made a score on the Blackstone test of 91.25, while the group that had used the traditional

material made a score of 85.54. This is a small difference, but each group was about 63 percent above the Blackstone norm for the amount of training given.

Each of Pearson's experiments indicates that the Miller Dictaphone Method is worthy of an extensive trial in the schools. However, the experiment of Marik shows that there are other methods just as effective. She compared this method with one of her own. It consisted of six weeks instruction in the manipulation of the machine, including how to reach for and strike each key. These operations were taught principally by means of dictation exercises. From this point on, progress was individual. Each day's lesson began with a few minutes of drill work and was followed by 10-minute exercises in paragraph-writing, after which each exercise was checked for number of lines and for errors. The pupils were motivated by praise, by the posting of their records, and by the inscribing of their names on an honor roll for having made unusual improvement. In the Dictaphone group, the instruction for the first six weeks was the same. Beginning with the seventh week the pupils were grouped into sections according to achievement. Each group was connected with one Dictaphone by means of multiple tubes. Individuals were shifted from one group to another according to their power to make progress. Their exercises were checked for errors, and before being allowed to try the same exercise again, they had to practice the words in which errors had been made. After the sixth week the progress of both groups was measured by giving the Blackstone tests once a week. During the remainder of the semester, the tests showed an approximate tie between the two groups, with sometimes one and sometimes the other in the lead.

Marik concluded that the Dictaphone method did not

yield superior speed and accuracy, that it made its greatest appeal to those of superior ability, and that knowledge of individual progress and personal encouragement are the major incentives to improvement. It appears that a machine or a particular method can never be a substitute for good teaching, but it may help teachers, both good and poor, to improve their teaching.

Learning Typewriting by Methods Which Approach Actual Work

An important principle in learning is to learn to perform an activity in the way it is done in life situations. In learning to drive nails it is better to practice driving nails rather than to whirl the hammer in beautiful curves. In learning handwriting it is better to practice writing rather than take exercises in posturing, relaxing, and making ovals. In typewriting it seems better to practice the kind of copy that is used in correspondence than something that is never used. Should the learner begin with disconnected letters, with disconnected words, or with meaningful composition? The first is often called the *A-B-C* or letter method; the second, the vocabulary or word method; and the third, the sentence or story method. The practice of the schools favors the first and second methods—the third one is rarely used. In the *A-B-C* method the first objective is to acquire mastery of the keyboard by writing nonsensical combinations of letters such as *zfaf, v;j;, xfsf, w;j;, cada, ,;k;, vafa, pj;j.* These are followed by exercises in familiar phrases such as *at some time, at all events,* and *in fact.* Such exercises are used for the major part of a semester, toward the end of which meaningful composition is gradually introduced. The latter, however, is frequently prefaced by some finger gymnastics for the sake of "warming up."

The vocabulary or word method. The vocabulary or word method is probably the most widely used in the schools. It is illustrated by a text, published in 1917,[7] which consists of four parts: (1) introduction to keyboard technique (lessons 1 to 18); (2) introduction to business correspondence (lessons 19 to 36); (3) introduction to business correspondence (lessons 37 to 54); (4) introduction to tabulation and billing (lessons 55 to 72). Each lesson is supposed to contain enough practice material for one week. The key positions for each finger are mastered one at a time, beginning with those for the first or index finger and ending with those for the fourth or little finger. The first exercise, for example, contains the following letter combinations and words: *jbfg, juyj, jug, fur, but, fun, buy, thumb,* and *jury.* In the word exercises, a line is written by repetition of one word. Later lessons contain similar exercises for the other fingers. After the letter positions for each finger are learned, the other marks of the keyboard are mastered. Some practice with sentences is introduced in the sixth week and some with paragraphs in the tenth week, but the first 18 weeks are devoted mostly to line exercises with words and digits, largely nonsensical material.

Theories underlying *A-B-C* and vocabulary methods. The theory underlying the *A-B-C* method is that since typewriting is done by striking one key after another, the logical way to learn typewriting is to master the keys separately. When the learner once knows the keys he is ready to begin writing words and sentences. The same theory underlies the word method, except that it has the further presupposition that since all copy consists of

[7] SoRelle, Rupert P., and Cutler, Ida M., *Rational Typewriting,* Revised Edition. New York: Gregg Publishing Company, 1917.

words, the material for drill should also consist of words. The order of the finger exercises and of the characters to be learned are based on the familiar precepts: *one thing at a time*, and *proceed from the familiar to the unfamiliar*. These assumptions seem logical enough, as far as they go, but some important factors are ignored, namely: the serial order of the reactions and the distribution of practice according to the frequency or use of the material. Typewriting is done by striking one key at a time, but the keys are always struck in a definite sequence—a sequence determined by the order of the characters in meaningful composition. Familiarity with the proper sequence is just as important as familiarity with the positions of the keys. In fact, rapid writing cannot occur unless the movement made in striking one key becomes the stimulus for the next correct movement, or until an entire series unfolds in response to some stimulus. But in writing disconnected words and letters, the sequence between the units used is always different from that found in meaningful composition. Then, too, some characters and words occur with far greater frequency than others. In the interest of accuracy, words and characters of frequent occurrence should receive more practice than rare words and characters. The attempt to give each letter, finger, and character an equal amount of practice violates such a principle and, therefore, is less conducive to speed and accuracy. Furthermore, the letter and word methods are monotonous and uninteresting, giving the learner a feeling that the practice is useless and unrelated to actual writing. It, therefore, fails to give a motive for zestful practice. Most of these difficulties would be avoided if the learner were permitted to practice what he is required to do in actual work; that

is, practice with material that is ordinarily used in correspondence and in keeping records.

The sentence or story method. As far as is known to the writer, no text has yet appeared which starts the learner with meaningful composition, although some are now introducing this sort of exercise much earlier than formerly. But Barton [8] has made experiments in which the rate of learning typewriting by the exclusive use of meaningful material was compared with the rate of learning when the traditional material was used. The experiments showed a decided advantage in favor of the former. In his first experiment, Barton used two groups: Group I consisted of 15 high-school pupils who used the traditional material, while Group II consisted of 12 high-school pupils who used business correspondence for copy. Group I began the first Monday in September and Group II started 11 weeks later. After the members of the latter group had learned to write without the aid of a chart showing the keyboard, each group began copying meaningful prose and two weeks later was given a speed test.

On the basis of the amount of time spent in practice, Group II (meaningful material) produced 4.56 times as good results as Group I. From the third week of January until the close of school, May 28, speed tests were made at intervals of one or two weeks. The median for these tests for Group II increased from 30.2 in Test 1 to 53.1 in Test 7. The corresponding increase for Group I was from 32.6 to 43.9. The scores represent words per minute less ten words for each error.

During the first seven tests Group II was noticeably superior to Group I, although in the finals the two were approximately equal. But in view of the fact that

[8] Barton, J. W., "Comprehensive Units in Learning Typewriting," *Psychological Monographs*, Vol. XXXV (1926), Whole No. 164. Also *Journal of Educational Psychology*, Vol. XII (1921), pp. 465–476.

Group II had eleven weeks less practice than Group I, the equality at the end of practice implies a great advantage in the use of meaningful material. The results, however, are only suggestive, for the groups were small, the practice was irregular, and the meaningful material used varied widely; in many cases, it was selected by the students themselves. Barton followed this experiment with a second one, the technique of which was somewhat better. Group Ia, which used disconnected material, followed the exercises in *Lessons in Touch Typewriting* by Ross, which begins with finger exercises in which nonsensical combinations of letters are used. Group IIa, which used meaningful material, followed the exercises in the *Vocabulary Method* by Birch, beginning on page 26, which deal with business correspondence containing the "1,000 commonest English words." The subjects were college students—13 in Group Ia and 16 in Group IIa. The practice continued for four months, Group Ia having an average of 40 practices, ranging from 17 to 56 per student, and Group IIa having an average of 41 practices with a range from 26 to 52. Speed tests of five minutes each were given daily during the last 48 days of the experiment. To make possible a comparison of the two groups, the students were given the Otis mental test; calculations were also made of their school marks, number of years in college, total number of letters written, final scores in letters per 5 minutes, and percent of errors in the final scores.

For the group using meaningful material, the average speed in the final test was nearly 2½ times as great as for the group using disconnected material. This is such a remarkable superiority for the use of meaningful material that it is well to inquire into the reasons. The group using disconnected material had a higher intelligence

score and a greater amount of practice than the other group, but one half year less of college work. The greater intelligence was probably no advantage, for the study of Davis has shown that increases in brightness above normality do not increase ability to learn typewriting. The greater amount of practice, however, should have favored both the speed and accuracy of this group. The half year less of college work was probably insignificant, for it is unlikely that this difference in amount of education at the college-sophomore level would make any difference in ability to learn typewriting. It seems, then, that the superiority of the group using meaningful material cannot be due to any advantage in ability. Barton concluded that the superiority was due to the material and that meaningful material is better because it agrees with the learner's determining tendency; that is, the learner practices what he sets out to learn. An additional reason seems to be that the practice is better distributed when meaningful material is used.

In one of Barton's tables showing the average number of letters struck by each student in each group, we find several wide differences. Thus the letter *b* had a frequency of 37 in Group Ia and a frequency of 3,246 in Group IIa; *h* had a frequency of 820 in Group Ia and 9,142 in Group IIa; *k* had a frequency of 10,984 in Group Ia and 772 in Group IIa; and *n* had a frequency of 189 in Group Ia and a frequency of 12,463 in Group IIa.

These data show that Group Ia had much less practice in the case of some letters and a much more in the case of other letters than is required in the writing of meaningful composition. Since there is a close relationship between amount of practice and percent of accuracy, it follows that Group Ia failed to develop speed and ac-

curacy at the necessary points. This experiment demonstrates that the unit used in learning typewriting should be the same as that used in commerce and other practical work, namely: the sentence and paragraph. In other words, we should practice what we set out to learn.

Parker's Experiment on the Direct Method

Additional evidence in favor of such a procedure is furnished by Parker's[9] experiment with what he termed the "direct method," the steps of which were designed to agree with what seemed to him the established principles of learning typewriting. The procedure was: the proper position was described; the student was taught how to adjust, insert, and remove paper; by means of a chart the proper position for each finger on the keyboard was taught; the keys were locked and the students were taught tapping; the words *if, it, is, he,* and *here* were taught; the work then proceeded to paragraphs, letters, and straight copy.

The advantages claimed for this method are: that it omits nonsense syllables, that typewriting is learned as it is used, that the keyboard is learned incidentally, that the word is the unit of instruction, and that the pupil is made familiar with the machine before instruction in typewriting is attempted. The progress of one experimental class and of three control classes was measured by means of the Blackstone tests, which were given every six weeks. The direct-method classes progressed in score from 88 to 159 while the traditional-method classes progressed from 59 to 115. Although the groups were

[9] Parker, G. H., "Direct Method in Typewriting," *Research Studies in Commercial Education*, Vol. V (1932), Iowa City, Iowa, University of Iowa, pp. 179–184.

not strictly balanced, the experimenter concluded that the method had enough merits to justify further trials.

Using the Thousand Most Common Words for Copy

If we assume that it is effective to practice what one sets out to learn, it is reasonable to suppose that typewriting-class copy should consist of the words most frequently used in business correspondence. We noticed, however, that double class periods are no more effective than single ones, a fact in agreement with the law of diminishing returns. The same may be true of the use of the most frequent words. In Pearson's experiment we saw that the class using meaningful copy based on the Ayres list of the most common words was much superior to the average class. But it was not much better than the class which used this method with other copy.

A second experiment on the value of using copy emphasizing words from the Ayres list was made by Green.[10] He experimented for one semester with two classes balanced in certain typewriting tests. One of them had copy which began with difficult letter combinations and led rapidly to rare and difficult words. The other practiced with copy made from the 1,000 most common words. During the semester, the class which had this copy progressed from 53.6 to 112.3 in the Blackstone tests, while the class which had work with uncommon words progressed from 53.9 to 98. There is, therefore, some advantage in using the most common words, but it is not great—a fact which may be due to the law of diminishing returns.

[10] Green, H. H., "The Relative Effectiveness of the Thousand Commonest Words in the Teaching of Typewriting," *Research Studies in Commercial Education*, Vol. V (1932). Iowa City, Iowa, University of Iowa, pp. 167–178.

Shall the Keyboard Be Learned by the Whole or Part Method?

The comparative economy of the whole and part procedures has been much experimented upon in the memorization of prose and poetry. The better method seems to depend upon the learner's span of attention. It is probably advantageous to have the learning unit as large as possible, although if too large a unit is attempted, much the same thing happens to the pupil as if he attempted to walk by taking steps much too long for his legs. Psychologically it appears that the best way to master the keyboard is to learn it incidentally while learning to write meaningful composition. But if the keyboard is to be learned before actual typewriting begins, then it is a question whether the letter keys should be learned from beginning to end as a unit or whether it is better to learn one row at a time.

Lomax made an experiment on the comparative value of these methods as applied to the keyboard of the typewriter. In the part method, one row of keys was learned at a time. In the whole method, the positions of the keys were memorized from charts—first the letter keyboard, then the shift keys, and finally the number keys. After memorizing these positions, the pupils had practice exercises consisting of sentences which employed the complete alphabet. All classes spent fourteen weeks in mastering the keyboard. The value of the methods was measured by means of the Blackstone tests, which showed, at the end of that time, that the achievement of the two groups in speed and accuracy was practically the same in all the classes. The group with the whole method started with a much lower speed and with more errors but made more regular progress than the group

using the part method. It is probably the more difficult of the two methods.

Should Rhythmical Movements Be Used in Learning Typewriting?

Some teachers of typewriting believe that typewriting movements should be learned rhythmically in time with a metronome, graphophone, or other musical instrument. This requires that all movements be made in approximately equal units of time. For example, in writing the word *mutton*, the time required to go from *m* in the first row, using the right index finger, to *u* in the third row, using the same finger, should be no less than the time required to move from *u* to *t*, which are tapped with the index fingers of the left and right hands, respectively. Obviously the time to change the same finger from the first to the third bank of keys is much longer than the time between taps of the corresponding fingers in the two hands. To make these two movements in equal units of time the second movement would have to be made much more slowly than necessary. In fact, to make all the movements in a perfect rhythm, all the sequences would have to be timed to the slowest one. It seems that such a procedure would not only be awkward, unnatural, and difficult, but a hindrance to developing maximum speed.

That such is the case was indicated in an experiment by Entwisle [11] on the value of rhythm in typewriting. Three classes were taught without any mention of rhythm and three other classes were taught to use rhythm. With the exception of rhythm, an effort was made to keep all conditions constant. Rhythm was de-

[11] Entwisle, Benjamin S., "An Experiment with Rhythm in Teaching Typewriting," *Research Studies in Commercial Education*, Vol. III (1928). Iowa City, Iowa, University of Iowa, pp. 75–83.

fined as "giving to each letter stroke an even, flowing touch, so that each key requires approximately the same amount of time as is given to the other strokes." The Blackstone tests were given each month to all the students. The average semester score for the rhythm group was 63.5, and for the non-rhythm group 66.8. From the six classes six pairs of pupils were found who balanced each other in intelligence. In this case, the median score for the rhythm group was 59, and for the non-rhythm group 68. The experimenter concluded that although the number of cases was too small to draw a final conclusion, the use of rhythm was not justified by this experiment.

Are Exercises in Finger Gymnastics Helpful in Learning Typewriting?

The value of taking five minutes for finger exercises at the beginning of each typewriting period was tested in an experiment by Crews. The exercises used were taken from Grisso's *Twentieth Century Touch Typewriting*, Wise and Smith's *Seven Speed Secrets*, and a list of exercises used by the Gem City Business College, Quincy, Illinois. They included: tapping on table with each finger in turn when hands and tips of other fingers were kept on table; tapping with each finger in turn when hands were flat on table and thumbs at right angles to fingers; moving each finger in turn sideways when hands were flat on table; closing each finger in turn tightly when hands were open, fingers wide, and muscles tense. Two classes were taught for nine months, the only difference in their instruction being that one of them had five minutes of finger gymnastics at the beginning of each period while the other did not. At the end of the year, a balanced group from each class was selected for comparison. The gymnastics group had an average score of 219 in the Black-

stone tests while the non-gymnastics group had an average of 181. The experimenter did not draw final conclusions but he believes that finger gymnastics are favorable to both speed and accuracy. Although this procedure is in disagreement with the principle that in learning one should practice what he sets out to learn, we must base our judgments on facts rather than on theories. The writer would like to see this experiment performed again.

Should Pupils in Learning Typewriting Erase Their Errors?

Most teachers of typewriting forbid the use of the eraser; yet in commercial life, erasures are frequently made. Blackstone,[12] working on the theory that allowing pupils to make erasures would develop a dislike for the privilege, made a controlled experiment on the value of using this privilege. The results showed that the erasing class developed a considerably better speed and accuracy by the end of the year than the nonerasing class. He recommends that other teachers experiment with this idea.

The Kind, Frequency, and Seriousness of Errors Made in Typewriting

In learning typewriting, students make a characteristic set of errors. Knowledge of the kind, frequency, and seriousness of these errors is very important because practice that is directed to the correction of errors is more effective than practice otherwise directed. Such knowledge is also valuable because it gives the teacher an idea of what to expect in his students. Studies relating to

[12] Blackstone, E. G., "An Experiment in Erasing in Typewriting," *Research Studies in Commercial Education,* Vol. V (1932). Iowa City, Iowa, University of Iowa, pp. 158–168.

errors were made by Book,[13] Lessenberry,[14] White,[15] and Rowe.[16] Book studied the errors made by the participants in the 1923 World's Championship Typewriting Contest, but the errors of such a select group are hardly typical of the majority of learners. Lessenberry studied in particular sequential and substitutional errors. White investigated the relative frequency of classes of errors, and Rowe investigated mechanical errors, or those relating to the operation of the machine. Lessenberry found, from an analysis of 60,000 errors, that certain keys had a much higher ratio of adjacent errors per key stroke than others. The descending order of these ratios for the respective keys was as follows: *v, k, g, b, d, f, c, m, s, r, w, u, n, y, l, i, p, t, e, o, a*, and *h*. Those adjacent to *q, z, x*, and *j* were negligible. The most frequent substitutional errors were made with vowels, such as *e* for *i*, *e* for *a*, *o* for *i*, *o* for *a*, *o* for *u*, *u* for *i*, *u* for *o*, *i* for *e*, *i* for *u*, *a* for *e*, *a* for *i*, and so on. The relative frequency of classes of errors, as discovered by White from an analysis of 20,623 errors was as follows: substitution (40 percent), omission (20 percent), spacing (15 percent), transposition (15 percent), insertion (3 percent), capitalization (2 percent), doubling (2 percent), syllabic division (1 percent), repetition of words (1 percent), and omission of words (1 percent). According to Rowe the most frequent mechanical or non-letter errors were the following:

1. Throwing the carriage
   (a) Wrong finger position

[13] Book, W. F., "Voluntary Motor Ability of the World's Champion Typists," *Journal of Applied Psychology*, Vol. VIII (1924). See also *Learning to Typewrite*, Chapter 23. New York: Gregg Publishing Company, 1923.
[14] *Op. cit.*
[15] White, W. T., *Typing for Accuracy*. Baltimore: H. M. Rowe Company, 1935.
[16] Rowe, C. E., "Correcting Non-Letter Errors in Typewriting," *Journal of Business Education*, Vol. V (1931), pp. 30–31.

(b) Pushing instead of throwing
(c) Whole arm instead of forearm
(d) Looking away from copy when throwing the carriage

2. Adjusting the carriage
(a) Misreading carriage-frame pointer on scale
(b) Using carriage release instead of space bar
(c) Wrong finger position on left carriage-release lever
(d) Wrong finger position on right carriage-release lever
(e) Does not know the number of line spaces to an inch

3. Adjusting paper
(a) Does not "twirl" cylinder knob
(b) Does not know the number of "clicks" to an inch
(c) Paper clamps too far over the edges of the paper

4. Spacing on the page, vertical and horizontal
(a) Cannot figure centering
(b) Does not know the number of vertical spaces to an inch
(c) Does not know the number of horizontal spaces to an inch
(d) Does not hear the bell
(e) Moves marginal stop instead of using left marginal release

5. Backspace Key
(a) Moves hand out of position
(b) Wrong finger on key
(c) Looks at key

6. Tabular Key
(a) Moves hand out of position

7. Space Bar
(a) Does not bend thumb, but keeps it straight and moves whole hand

Another arrangement of errors which should be kept in mind from the standpoint of reaching high efficiency is their seriousness in relation to the mailability of the materials. A study of the seriousness of errors from this point of view was made by Morrison.[16a] After selecting a list of representative errors he put one of them into each of twenty-eight letters. Three hundred sets of these letters were sent out to judges, who were asked to classify them into three groups: (1) mailable without correction; (2) mailable after correction; and (3) unmailable. Clas-

[16a] Morrison, N. B., "An evaluation of Typewriting Errors," Monographs in Education, No. 12. *Research Studies in Commercial Education*, Vol. V, pp. 153–157, University of Iowa, 1932.

sification of errors from this standpoint were as follows:

Group 1

Two spaces between words
Incorrect space after punctuation

Group 2

Capital letters not on line
Struck over letters slight
Failure to capitalize proper word
Incorrect punctuation after complete close
Misspelled word
Transposed letters
Omission of hyphen
Plural for singular
Proper name misspelled
Errors in figures

Group 3

Transposed word
Poor placement
Word repeated
Incorrect division of word
Word omitted
Untidy erasures
Omission of line

Mixed classification

Uneven indentation of paragraphs
Letter not straight on page
Uneven left hand margin
Uneven right hand margin
Incorrect punctuation in body of letter
Space omitted between words
Ghost letters

Possible Improvement of Speed and Accuracy in Typewriting by a Rearrangement of the Keyboard

To get maximum speed on the typewriter, the keys for letters having the highest frequency in the English language should be so placed that they can be reached with the shortest and easiest movements, and the work for each finger should be in proportion to its strength. R. E.

Hoke [17] undertook an investigation for the purpose of achieving these results. To find the frequency of the letters, he counted the letters in the Ayres list of 1,000 words, the sixteenth chapter of Mark's gospel, a group of representative business letters, and a newspaper editorial. In the last three sources the periods, commas, colons, and semicolons were also counted. The results showed that if *e* became charged with a frequency of 1000, the other letters and marks could be arranged in a descending order of frequency until *z* was reached with a frequency of only 9. Arranged according to relative frequency the order of the letters of the alphabet was *E, T, A, O, S, I, N, R, H, L, D, C, U, M, Y, B, P, W, F, G, V, K, J, X, Q, Z*. The order of four punctuation marks was period, comma, colon, and semicolon.

If this order of frequencies is correct, it should follow on the principle that practice makes perfect that the per-cent of accuracy with which each letter is written should have the same order. To find whether this was true, Hoke counted the errors for each letter of the alphabet in 500 pages of typewriting material obtained from as many high-school pupils. The count was stopped when the letter *e* became charged with 1000 errors. The correlation between frequency of letter and frequency of error was found to be .924, but the correlation between frequency of letter and percent of error was —.567, showing that the accuracy is about what we would expect from the order of frequency of the letters.

To find the relative strength of the fingers, Hoke gave tapping tests to each of 96 high-school pupils, and to 54 adults. His procedure was to have the subject hold his thumb on the frame of the typewriter in front of the space bar and tap for 30 seconds one of the keys in the middle

[17] Hoke, Roy E., *The Improvement of Speed and Accuracy in Typewriting*. Johns Hopkins University Studies in Education, No. 7, 1922.

bank. On the assumption that the number of taps in a half minute indicated the strength of a finger and that the frequency of letter indicated the actual load on a finger, he compared the two and calculated the percent of overload and underload on each finger. According to the results the first two fingers of each hand were greatly overloaded but the remainder, with the exception of the third finger of the right hand, were greatly underloaded. In a similar manner, Hoke found that the left hand, relative to its strength, was overloaded 47.7 percent by the actual load it carried on the standard keyboard. As a remedy, Hoke proposed a new arrangement of the keyboard, although he made no actual trials of its merits.

The need of a new keyboard was also pointed out by Dealey and Dvorak,[18] who found four defects in the standard keyboard, namely:

1. It requires the operator to write too many words with one hand: 300 words with the right and 2,700 words with the left hand.

2. It presents unnecessary finger-striking difficulties; for example, adjacent finger reaches like *aw, se, sc, as,* and *we;* adjacent finger hurdles like *be, ve, xe,* and *ui;* and single-finger sequences like *ik, ju, fr, de, ed,* and *lo.*

3. It handicaps the typist by breaking his rhythm through some finger sequences, as in the wide difference in the time between sequences by fingers of different hands and sequences by the same finger in one hand, when one letter is in the upper row and the next letter in the lower row.

4. It is unbalanced with respect to hand, finger, and row loads—the left hand is called upon to do 47 percent more work than the right and the middle row carries only 32 percent of the load as against 52 percent by the upper row and 16 percent by the lower row.

To remedy these difficulties, they designed a simplified keyboard which reduced the number of common words

[18] Dealey, W. L., and Dvorak, August, "A Newer, More Fluent Mode of Expression in the Public Schools," *Educational Outlook,* Vol. VIII (1934), pp. 150–153. Also, Uhl, W. L., and Dvorak, August, "Cost of Teaching Typewriting Can Be Greatly Reduced," *The Nation's Schools,* Vol. XI (May 1933).

typed by the left hand from 2,700 to 69; reduced the number of common words typed by the right hand from 300 to none; equalized the loads on the two hands; changed the load in the home row from 32 to 80 percent, with corresponding reductions in the upper and lower rows; reduced the awkward and difficult sequences from 30 percent to 3 percent; and adjusted finger load to finger strength. They claim that the new keyboard, which is shown below, is easier to master, faster, more accurate, and less fatiguing.

SIMPLIFIED KEYBOARD

Back Spacer	# 7	(5	) 3	" 1	% 9	_ 0	¢ 2	$ 4	@ 6	* 8	Tabular Key
	: ?	' ,	· .	P	Y	F	G	C	R	L	& /
	A	O	E	U	I	D	H	T	N	S	½ -
Shift Key	; ;	Q	J	K	X	B	M	W	V	Z	Shift Key

Space Bar

STANDARD KEYBOARD

Back Spacer	" 2	# 3	$ 4	% 5	_ 6	& 7	' 8	(9	) 0	* -	Tabular Key
	Q	W	E	R	T	Y	U	I	O	P	¼ ½
	A	S	D	F	G	H	J	K	L	: ;	@ ¢
Shift Key	Z	X	C	V	B	N	M	? ,	. .	¾ /	Shift Key

Space Bar

According to a study made by Davis [19] on groups of junior high-school, senior high-school, and junior-college

[19] Davis, Dwight D. W., "An Evaluation of the Simplified Typewriter Keyboard," *Journal of Business Education*, Vol. X (May 1935), pp. 11–12; Vol. X (June 1935), pp. 10–29; Vol. XI (Sept. 1935), pp. 21–22; Vol. XI (Oct. 1935), pp. 19–21.

students, the number of errors made on the simplified keyboard is only half as great as on the standard keyboard. The difficult words or "Typewriting Demons" are long words rather than little ones. This is shown in the first fifteen difficult words for each keyboard. On the standard keyboard they are *the, to, and, of, is, which, it, that, for, with, when, have, be, would,* and *will.* On the simplified keyboard, they are *new, beautiful, during, everything, help, oblige, certain, company, length, October, possible, result, serve, stamp,* and *never.* The hundred words most frequently mistyped on the standard keyboard account for 45 percent of all the errors; on the simplified keyboard they account for only 26 percent of the errors. The time required to learn the simplified keyboard is much less than for the standard. Senior high-school students reach in one semester a median speed of 37.5 net words per minute. This compares with 16.5 for one semester, 28.4 for two semesters and 40.9 for three semesters on the standard keyboard, as found by Kibby,[20] in California high schools. In two semesters, senior high-school students reach a median speed of 48 net words per minute. This compares favorably with that obtained in four semesters in some high schools and in six semesters in others on the standard keyboard. Junior high-school pupils reach a median achievement of 27.1 net words per minute in one semester and 36.1 in two semesters. Kibby found the corresponding scores on the standard keyboard to be 10.6 and 21.4, respectively. If these results are confirmed by other investigators, they justify the use of the new keyboard for beginners. It is possible that even experienced typists would find it advantageous after a period of relearning.

[20] Kibby, Ira W., *A Study of Typewriting Accomplishments in California Secondary Schools.* State Dept. of Education, Sacramento, California, March 1933.

Individual Differences

Length of study. Proficiency in typewriting varies in relation to length of study, grade, age and sex of the learner, and other factors. A number of studies have been made which show these facts. Carmichael [21] and Wood [22] made investigations of the relation of speed to the number of semesters studied. Carmichael studied schools in Indiana, while Wood studied schools in California. The results are given in Tables 12 and 13.

TABLE 12

MEDIANS AND RANGES IN WORDS PER MINUTE IN TYPEWRITING IN RELATION TO SEMESTERS OF STUDY

(From Carmichael, 1932)

Semester	No. of schools reporting	Median	Range
I.	94	20	40–10
II.	119	35	70–20
III.	[illegible]	45	75–30
IV.	62	50	80–30

The relation of typewriting to age, grade, and sex was investigated by Owens [23] and by Rowland.[24] Their results are given in Tables 14 and 15.

Rowland made an experiment in teaching typewriting to children in Grades V and VI for one semester. The results were measured by means of the Blackstone tests.

[21] Carmichael, V. H., *Objective Measurement of Accomplishment in High School Commercial Pupils in Indiana.* Monographs in Education No. 12, University of Iowa Research Studies in Education, 1932.

[22] Wood, Winifred M. G., *Relationship between Intelligence Quotient and Achievement in Typing.* Master's thesis, University of Southern California, 1928.

[23] Owens, Chas. B., *A Survey of Typewriting Achievement at the End of the First Year, Speeds Attained and Errors Made.* Master's Thesis, New York State College for Teachers, Albany, 1930.

[24] Rowland, Ralph S., "An Experiment in Teaching Touch Typewriting to Pupils in Fifth and Sixth Grades," *Elementary School Journal,* Vol. XXX (1930), pp. 533–538.

For comparison he also included the results from junior high-school pupils, senior high-school pupils, and college students. They are given in Table 16.

TABLE 13

AVERAGES IN WORDS PER MINUTE FOR TYPEWRITING IN RELATION TO SEMESTERS OF STUDY AND GRADE

(From Wood, 1928)

Semester	Grade	Average rate
I	IX	15.56
II	IX	23.84
III	IX	25.02
I	X	18.14
II	X	30.74
III	X	26.68
I	XI	20.88
II	XI	28.72
III	XI	31.90

TABLE 14

MEDIAN WORDS PER MINUTE IN TYPEWRITING AFTER TWO SEMESTERS OF STUDY ACCORDING TO GRADE IN HIGH SCHOOL AND SEX

(From Owens, 1930. 4716 papers)

Grade	Speed	
	Boys	Girls
IX	21	22
X	23	25
XI	26	29
XII	29	32

The fact that the pupils in Grades V and VI made better scores than the Chicago junior high-school pupils must not be taken as representing a typical situation. These pupils were in an experimental class and were taught by the best methods. The experiment is important in show-

ing that pupils in the elementary school can learn typewriting. However, if we compare the scores of junior high-school, senior high-school, and college classes, we should say that it is uneconomical to teach typewriting to pupils below Grade IX.

Summarizing the results of skill in typewriting in relation to length of study, age, grade, and sex, we see that

TABLE 15

MEDIAN WORDS PER MINUTE FOR FIRST YEAR OF TYPEWRITING ARRANGED ACCORDING TO MOST FREQUENT AGES OF CHILDREN AND SEX

(From Owens, 1930)

Age	Speed	
	Boys	Girls
13	25	23
14	21	23
15	20	25
16	23	26
17	26	27
18	26	27

TABLE 16

SCORES IN THE BLACKSTONE TESTS IN TYPEWRITING IN RELATION TO WEEKS STUDY (7 TO 15) AND GRADE

(From Rowland, 1930)

Weeks of Practice	Blackstone norms	Scores			
		Grades V & VI (19 pupils)	Teacher's College Class	Chicago Jr. H. S. (28 classes)	Chicago Sr. H. S. (30 classes)
7	41	25	52	28	30
8	44	35	58	31	34
9	48	34	63	34	39
10	51	36	68	37	44
11	54	40	69	39	49
12	58	43	69	40	55
13	61	51	75	41	60
14	64	42	81	41	65
15	67	54	83	42	70

skill improves in relation to length of study, maturity of the pupil, and grade level. Girls, age for age, during the ages studied, are somewhat superior to boys.

Individual differences in relation to amount of practice. Individuals differ widely in skill in relation to amount of practice. Table 17 shows some interesting variations among 20 high-school pupils.[25]

After 25 hours of practice, the scores range from 25 to 85 words in five minutes; and after 145 hours of practice, they range from 145 to 325 words in five minutes. After 175 hours of practice the variation was somewhat reduced. From this it appears that practice increases the differences between individuals. This tendency may also be seen from individual cases. For example, after 26 hours of practice individuals *D* and *N* made scores of 48 and 93 words, respectively, in five minutes. After 170 hours of practice the corresponding scores were 241 and 307. The absolute difference between them increased from 45 at 26 hours, to 60 at 170 hours. Such a comparison, however, does not mean that the intervening practice made *N* relatively more efficient than *D*. To make a judgment upon this we must compare the ratio of the two individuals at the beginning of practice with the ratio at the end of practice. Doing so, we find that *N* wrote 5.02 times as many words in five minutes as did *D*, but at the end of practice he wrote only 3.25 times as many, and this in spite of the fact that *N* added 208 words per five minutes of his score while *D* added only 193. The effect of practice in this case was to decrease the relative differences between the individuals, although it increased their absolute differences for a time.

The practical problem, however, is the adjustment of the instruction to individual ability. Such adjustments

[25] Chapman, J. Crosby, "The Learning Curve in Typewriting," *Journal of Applied Psychology*, Vol. III (1919), pp. 252–268.

are not possible in exercises in class dictation, but only a small part of the instruction in typewriting needs to be of this type. After a pupil is familiar with his keyboard

TABLE 17

VARIATION IN TYPEWRITING IN RELATION TO HOURS OF PRACTICE
(From Chapman, 1919.)

Words in 5 minutes	Hours of Practice					
	25	55	85	115	145	175
25*	4					
35	8					
45	12					
55	14					
65	4	1				
75	1	1				
85	3	6				
95	...	6				
105	...	5				
115	...	8				
125	...	7	3			
135	...	4	2			
145	...	4	2		1	
155	...	7	7			
165	...	2	2	1	1	
175	...	1	3	1		
185	...	2	3	2	2	1
195	...	2	6	6		2
205	...	1	11	8	3	1
215	...	...	6	4	2	4
225	...	1	8	2	4	2
235	...	...	1	4	4	9
245	...	...	...	6	5	5
255	...	...	...	1	2	3
265	...	...	1	1	2	6
275	...	...	...	2	1	
285	...	...	...	1	1	1
295	...	...	...	1		1
305	...	...	...	...	1	2
315	...	...	...	...	...	1
325	...	...	...	...	1	

* 25 words means any number from 20 to 29.

These are records from 20 pupils. Each one may have 4 or 5 scores during a 10-hour period.

he can follow the exercises in his textbook without much assistance. If he uses a Dictaphone he can select a record that suits his own speed. When the exercise is completed, he can calculate his own errors, speed, and efficiency, and make charts of them. With all these opportunities for individual progress and checking, the matter of individual instruction is really not a problem in typewriting. Rather it presents us with an ideal to which instruction in other subjects should conform.

The Prognosis of Typewriting Ability

For the purpose of vocational guidance numerous studies have been made during the last fifteen years to find a set of tests which would measure the ability to learn typewriting with sufficient accuracy to make it possible to eliminate failures in advance. Most investigations find at least one test which has a fairly high correlation with success in typewriting, but the next investigation is more than likely to find that the same or a similar test has a low or negligible correlation with success in typewriting. No one has yet found a set of tests on the basis of which he would be willing to advise an individual student not to take typewriting, although he might be willing to say whether the chances of success were favorable or unfavorable. Of course, perfect prediction is not to be expected, but no set of tests has yet been found which enables one to say that the chances of success or failure are as large as 60 out of 100.

The general method of attack in these studies has been to analyze the component abilities in typewriting, make up tests for measuring them, then correlate the scores with a criterion of success in typewriting. For example, Bills,[26]

[26] Bills, M. A., "Methods for the Selection of Comptometer Operators and Stenographers," *Journal of Applied Psychology,* Vol. V (1921), pp. 1, 2, 283 (A study of intelligence, special ability and character tests as measures of typewriting ability).

who considered intelligence an important factor in success in typewriting and stenography, gave an intelligence test and a number of other tests to 84 students taking a course in stenography. After comparing the scores in the intelligence test with the scores made in the course, he found that 86 percent of the students could have been correctly placed by the intelligence test alone. In a later investigation, Ohmann [27] found a correlation of only —.02 between intelligence and typewriting ability, a result which has no predictive value. A still later and more careful investigation made by Wood [28] showed that the correlations ranged from .10 to .31 with an average of about .168, a figure which is much too low to have any value for vocational guidance.

To give a more exact idea of the nature of these studies and of the character of the results, we shall report the essential facts about one of them, that by Korngold.[29]

Korngold studied the possibility of predicting success in typewriting from tests of spelling, substitution, intelligence, handwriting, reading, age, and the McQuarrie test of mechanical ability. The latter is a tracing test in which the subject is required to start at a given point and draw a line passing through many small rectangles located at gaps in the line, care being taken not to touch the sides. Correlation of these tests with typewriting were calculated in the case of 73 subjects, with the results found in Table 18.

The regression equation of typewriting (x_1) on the two best tests, spelling (x_2), and substitution (x_3), turned

[27] Ohmann, O. A., "The Possibility of Prognosis in Stenography," University of Iowa *Studies in Education,* First Series, No. 7, 1926, pp. 36–41.

[28] *Op. cit.*

[29] Korngold, Helen, *An Experimental Study of Certain Tests as a Means of Predicting Success in Typewriting.* Master's thesis, Washington University, St. Louis, 1930.

out to be $x_1 = 6.426\ X_2 + 1.762\ X_3 - 126.58$. It had a multiple correlation with typewriting of .68, which means an ability to predict 29 times correctly out of 100.

TABLE 18

CORRELATIONS BETWEEN VARIOUS TESTS AND SKILL IN TYPEWRITING (From Korngold, 1930)

Test	Correlation	Probable Error
Spelling	.507	.058
Substitution	.488	.059
Intelligence, N.I.T.	.230	.071
Handwriting	.154	.076
Burgess Reading	.06	.078
Age	.18	.075
McQuarrie test	.06	.078

The conclusion to be drawn from these studies is that successful prognostic tests of typewriting ability have not yet been found and that, although there are measurable traits which have a definite relationship to typewriting, there are none with enough reliability to apply with success to individual cases.

There are at least two important questions in need of more definite solution before we can hope to predict typewriting ability successfully. One of them is to find a reliable and workable criterion of success in typewriting. Shall it be accuracy, or speed, or a combination of the two? The other question is the assumption that there are certain specific abilities in an individual, either natural or acquired, which are necessary for success in typewriting. It is possible that typewriting ability is not dependent upon any group of specific abilities and that its learning is a function of that general adaptability of the human organism which is possessed by all who can succeed in the elementary school. If this is the case, the

possibility of predicting success in typewriting from a specific set of tests is rather hopeless.

Summary

Sustained practice, good health, and intense effort have been found to be important factors in accomplishing better methods in typewriting.

The touch method is more rapid than the sight method. It eliminates the necessity of memorizing the copy and of eye movements between the copy and the keyboard, and makes possible a direct connection between the sight of the copy and the striking of the keys. The sight method, however, has an initial advantage in making possible a quicker and more accurate location of the keys.

Distributed practice accelerates the rate of learning. One hour a day for forty-five days yields a greater final speed than nine hours a day for five days, although each is valuable. Single periods in the secondary schools produce practically as good results as double periods. The additional hour may be much more profitably spent on something else.

Diagnostic teaching followed by corrective drills, knowledge of improvement, and rewards for success has been found to be an effective method for motivating and accelerating the rate of learning typewriting.

Dictaphone exercises, which have been graduated in speed, have been found to yield 63 percent more gain in a semester course than the traditional exercises found in textbooks. The reason for this is probably that the Dictaphone record gives the learner a motive for maximum effort and speed.

Practicing what one sets out to learn has been found to be an effective principle to follow in learning typewriting. In a secondary school, the use of meaningful com-

position, made up or selected by the pupils, was found to yield 456 percent more gain on the basis of the amount of time spent in practice than did the use of the exercises found in the textbook, which, for the most part, consisted of disconnected letters and words. With college freshmen and sophomores the use of meaningful composition produced about 250 percent more gain during forty hours of practice than did the letter and word exercises selected from a textbook. Among the reasons for this are that the practice on each element is more in proportion to the frequency in typewriting material, and that it is in proper sequence.

In another experiment in which an effort was made to have the students practice what they set out to learn, the following order of instruction was followed: getting proper position, inserting and removing paper, determining positions for each finger, doing tapping exercises, writing simple words, and writing straight copy. It yielded better results than the traditional method.

There is no great advantage in using copy made from the thousand most common words used in business correspondence, a fact which may be due to the law of diminishing returns.

There is little difference between the whole and part methods of learning the keyboard. It probably should be learned incidentally.

Attempting to give all strokes an equal time and using rhythm in writing retards the rate of learning.

Using finger exercises for the first five minutes of the typewriting period has been found to be effective for developing speed and accuracy.

Allowing pupils to erase errors has been found to develop more speed and accuracy than prohibiting them.

Learners of typewriting make a characteristic set of

errors. It has been found that large gains will be made by analyzing these for each learner and devising proper corrective exercises for them.

The standard keyboard greatly overloads certain fingers and underloads others in proportion to their relative strength. It is believed that a scientifically designed keyboard which would be free from these objections would make possible much greater speed and accuracy.

Skill in typewriting improves in relation to length of study, maturity of the pupil, and his grade level. Girls are slightly superior to boys of the same age and training.

Individuals differ widely in ability to learn typewriting, but the adjustment of instruction to these differences presents few difficulties. The pupil learns by doing. He can follow his exercises with little assistance, analyze his own errors, calculate his own score, and keep a record of his own progress. We have here an ideal to which instruction in other subjects should conform.

Psychologists have found the analysis and measurement of typewriting ability an attractive field for investigation. So far, each investigator has found some tests which correlate well with typewriting and some which correlate poorly. It is rare for two investigators to find results which agree. For the present, typewriting ability cannot be reliably predicted from tests which do not measure achievement in typewriting.

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CHAPTER 14

The Social Studies: Objectives and Organization

Opinions of the Committee on Social Studies

According to the Committee on Social Studies of the Commission on the Reorganization of Secondary Education of the National Education Association,[1] the social studies are understood to be those whose subject matter relates directly to the organization and direction of human society, and to man as a member of society. Their purpose is to train individuals for membership in society and to make them socially efficient, in other words, good citizens. The good citizen is the "thoroughly efficient member" of a neighborhood. He has a loyalty and sense of obligation to his city, state, and nation, and also a sense of membership in the world community, as well as the sympathies and sense of justice that this involves. The usual branches of the social studies pursued in the secondary schools are history, civics, and geography, and more rarely, sociology, and economics.

Although many investigations have been made of the particular objectives of the social studies, there is actually no scientific way of determining what they should be. Purposes or objectives are matters of opinion and desire, and depend on one's philosophy of life. Science does not determine what ought to be, but only records what is. Accordingly, the function of science with respect to the

[1] Dunn, Arthur W., *Report of Committee on Social Studies of the Commission on Reorganization of Secondary Education.* Bureau of Education, Bulletin No. 28, 1918.

objectives of the social studies is to record and count the objectives which people believe belong to them. Such investigations have been made of the opinions of teachers, of authorities on the subject matter of the social studies, of educators, and of the general public as it has expressed itself in the press and in political platforms. We shall refer to one of them.

Opinions of the Commission on Social Studies

The most important recent investigation of objectives of the social studies is contained in Part I, Report of the Commission on the Social Studies, prepared by a special sub-committee of the American Historical Association[2] consisting of C. A. Beard, G. S. Counts, G. S. Ford, A. C. Krey, C. E. Merriam, F. A. Bobbitt, B. H. Bode, and H. O. Rugg. It is entitled *A Charter for the Social Sciences,* and was written by Charles A. Beard. According to this report the program of the social studies must first of all strive toward the ideal of the scholar—truth. It must meet the requirements of the social realities, namely: the changing nature of society; the industrialism characteristic of Western civilization, which requires individuals excelling in alertness, mobility, and ingenuity; the system of government under which we live, which is elective and is of the people, by the people, and for the people; the operation of the American government under the pressure of political parties with their numerous controversial questions; and the necessity of instruction in the processes of government. It also must be in harmony with the tenor of American ideas, the most important of which are the promotion of the general welfare, liberty, and justice.

For the individual, welfare requires a sound body safe-

[2] Beard, Charles A., *A Charter for the Social Sciences in the Schools.* Report of the Commission on Social Studies, Part I. New York: Charles Scribner's Sons, 1932.

guarded by all the knowledge, means, and services commanded by modern science. To give him that knowledge, a full health program of education must be provided. Each individual must have economic security, and the enjoyment of leisure. To make these possible, there must be universal facilities for education from childhood to old age, and equality of opportunity to earn a livelihood. The principle of liberty means that the individual "is entitled to his rest and to freedom from the continuous demands of society, to a high degree of privacy in personal affairs, in individuality in dress, mode of living, and religious, economic and political beliefs." That is to say, toleration is a fundamental American idea and implies, among other things, a firm belief in the beneficent effects of freedom of thought. Underlying all these material ideals is the belief that evils can be corrected, as well as the ethical impulse to see a more even distribution of the benefits of civilization.

Instruction in the social studies must also be adjusted to the goals which the American nation has set for itself. Among these are national planning in industry, business, agriculture, and government; the expansion of insurance systems to cover the hazards of civilized life; universal education; the perfection of systems of transportation; the development of city, community, regional, and state planning, coördinated with national designs; expansion of present facilities to include a national program of preventive medicine, public and private, and science, letters, and the arts; equality of opportunity for all men and women to unfold their talents; and coöperation with the other nations of the earth in the promotion of travel, commerce, and peace.

The supreme objective of the social studies is "competence in the individual." "Our fundamental purpose here

is the creation of rich, many-sided personalities, equipped with practical knowledge and inspired by ideals so that they can make their way in a changing society which is part of a world complex." Such an individual must have information, he must know the sources of information, the methods of acquiring it, and how to analyze and synthesize it. He should have habits of cleanliness, industry, courtesy, promptness, accuracy, and effective coöperation. He should also have certain attitudes, such as respect for the rights and opinions of others, zeal for truth, pride in the achievement of individuals, admiration for disinterested deeds, faith in the power of men to improve, a lively interest in contemporary affairs, and above all, love of country, or patriotism. In addition to these, he must have will power and courage. In the interest of leadership, especial stress is to be put upon inventiveness and adaptability as objectives of a social education.

In this report, Beard undoubtedly strikes at fundamentals. Two questions may be raised in regard to it: first, whether the objectives mentioned are the peculiar objectives of the social studies or whether they are those of education in general; and, second, whether any fundamentals have been overlooked. In regard to the first question, it seems that the report fails to distinguish between the objectives of the social studies and the objectives of education in general. Such objectives as competence in the individual; the creation of rich, many-sided personalities equipped with practical knowledge; information and knowledge of how to get it; powers of synthesis and analysis; habits of courtesy, promptness, accuracy and effective coöperation; respect for the rights and opinions of others; zeal for truth; pride in achievement; faith in the power of men to improve; the development of ingenuity and adaptability; love of country, and so on,

are and should be striven after by every teacher, regardless of the subject he teaches. They are not, properly speaking, subject-matter objectives, but objectives, ideals, or ends of education in general.

What Beard says of the necessity of adjusting the instruction in the social studies to the goals of the American nation and the climate of American ideas is more rightly the peculiar function of the social studies. An exposition of our national ideals and tendencies would not be expected in any other but the social studies—certainly not in language, natural science or mathematics. With respect to the tenor of American ideas, the institution of private property seems to have been overlooked as a fundamental implication of the ideas of liberty and the pursuit of happiness. Along with private property, we have the philosophy of individualism and of capitalism as other important products of the concept of liberty. These have been the dominating concepts in our social structure up to the present, and around them have centered our territorial expansion, the settlement of our territories, the westward movement of our civilization, our great inventions, our industrial development, the accumulation of great wealth, and even the building up of our schools and the education of our children. To these concepts we owe most of our failures as well as our successes. Among our failures we may mention widespread unemployment and want, the poverty of great numbers of people, periodic depressions and breakdowns of credit, unhygienic living conditions in congested areas, and the limited educational facilities often found in poor districts. To overcome these evils, at least partially, we must teach the necessity of consciously ordering our society in the interest of the common welfare and of making this instead of private gain the primary incentive of our endeavors.

But with all this, we must not overlook the values of individualism, capitalism, and private property in the United States. In a democracy there evidently is a happy medium between communism and rugged individualism.

Concluding Statement on Objectives

From the great number of objectives that have been set forth for the social studies it is difficult to select those on which there would be wide agreement. We should say, however, that training for membership in society is the proper goal for the social studies. Membership in society means membership in the world community, in the national, state, and local communities, and in the home. For membership in the world community, the social studies should teach the cultural and economic interdependence of nations, the social changes resulting from industrialism, the importance of the renunciation of war as a national policy, the merit of the judicial settlement of international disputes, the values of the peaceful arts for culture and happiness, the importance of commerce and travel between nations, and the story of the development of modern nations. For membership in the nation they should teach the history of the nation, and our national ideals, such as the priority of the general welfare; the individual's health, economic security, and leisure; universal educational facilities and equality of opportunity in education and in industry; the prevalence of liberty with its implications of toleration, freedom of thought, and private property; the functioning of the processes of democratic government; and skill in performing the duties of citizenship, as well as the historical development of these ideals and values. In addition to these there should be developed a love of country. For membership in the state and local community, the social

studies should give the student a knowledge of the development of the state and community and of the relation of the state government to the local and federal government; skill in discharging the functions of a citizen in local and state government; habits of safety, fire prevention, hygiene, and protection of property; an attitude of individual responsibility; an interest in beautifying the community and the home; an understanding of the principal conflicts incidental to our society; and an understanding of the principal social institutions, such as the family, the school, the church, and public utilities. The acquisition of all these facts, skills, and attitudes should not only contribute to the realization of the ends of education in general, but should also give the individual competence in dealing with the insistent problems of his generation.

Organization by Study Methods

The realization of the objectives of the social studies depends in part on the acquisition of certain concepts, and in part upon the formation of certain habits, attitudes, and beliefs. The conceptual organization is derived largely from reading materials and from other symbolic representations of facts, and this in spite of the fact that there are many available concrete materials which should be far more widely used than is the case at present. The methods used may be discussed in two groups, namely: (1) study methods, and (2) methods of presentation. In this chapter we shall discuss study methods, and in the next one, methods of presentation.

Methods Suggested from Other Subjects

Our sources of information on study methods are both

inferences from effective methods in other subjects and results of experiments in the direct teaching of the social studies. As the information is acquired principally by reading, all methods which have been found effective in reading have a direct application to the social studies.

Our study of typewriting suggests that drill is necessary for the mastery of the facts of the social studies. Our study of foreign languages leads us to believe that the transfer values of the social studies would be small. For example, the study of American history in the usual way—that is, by reading and reciting from a textbook—would be of very little aid in discharging the actual duties of citizenship such as balloting, selecting a candidate for office, organizing a mothers' club for better child-training, or organizing an independent political party. If skill in such activities is to be taught, something more than the traditional form of teaching must be used.

The study of English composition suggests that it would be valuable in teaching the social studies to know pupils' difficulties in them, that corrective devices of the right sort would be helpful, and that benefits would also be derived from supervised study.

The study of literature also supplies a number of practical suggestions. For example, historical readings should be graded for different age and mental levels just as are literary readings. For the youth, they should be written so as to make a strong appeal to the interest in adventure and occasionally to the interest in love if the material is suitable. They should appear in story form instead of in series of choppy paragraphs, as is usually the case. As methods of stimulating interest, book lists, book reports, current events, and dramatization should be just as effective for history as for literature.

Methods Suggested by Experiments in the Social Studies

Although many methods of instruction are suggested for the social studies by the teaching of other subjects, we need not depend on them entirely, for many investigations have been made directly on teaching the social studies. These are so varied that it is difficult to classify them into logical groups, but in spite of this we shall review them for their practical value.

Advance Questions

Giving questions in advance or at the head of an assignment has been found to be an effective procedure in the study of social-science materials. Such questions give the reader ideas of what to look for and enable him to form a favorable mental set for the comprehension of the points suggested. They may, it is true, form an attitude of inattention to points in the content not covered by the questions, but even so, there is probably more gain than loss. However, if such points are important, they should be covered by the questions. The value of advance questions was investigated by Washburne[3] and by Gatto.[4] The latter investigated the use and placement of questions in the study of an assigned lesson in history, while Gatto investigated the use of advance questions in connection with supplementary materials.

Washburne gave attention particularly to the use and placement of questions in regard to the ability to recall facts and to make generalizations. For this purpose he prepared an historical account about 3,000 words in length of the story of the City of Florence, in five forms:

[3] Washburne, John N., "The Use of Questions in Social Science Material," *Journal of Educational Research*, Vol. XX (1929), pp. 321–359.
[4] Gatto, Frank, "The Enrichment of Historical Reading," University of Pittsburgh, *School of Education Journal*, Vol. II (1927), pp. 3–8.

S, *T*, *Y*, *Z*, and *X*. Form *S*, used by the control group, had no questions. The remaining forms, used by experimental groups, had questions. Form *T* had them at the beginning of the story; Form *Y* had them interspersed at the beginning of appropriate paragraphs; Form *Z* had them interspersed at the end of appropriate paragraphs; and Form *X* had them all placed at the end of the story. Twenty-five minutes were allowed for the reading of the story, after which identical tests were given to all the pupils participating. A group of 1,456 pupils from Grades VII and VIII took part. Out of these, five equivalent groups, totaling 860 pupils, were selected. From their results the conclusions of the study were drawn. The questions in the test consisted of two general types, those on facts and those on generalizations.

The pupils who had the benefit of questions placed at the beginning of the story made the best score. The next best placement was found to be at the beginning of paragraphs, but this was very little better than placing questions at the end of paragraphs. Placing the questions at the end of a story was less effective than no use of questions at all. In view of the widespread custom of placing questions at the end of chapters in textbooks, this is an interesting fact. Washburne's results also showed that the influence of the placement of the question was related to the type of question. For example, the scores on the generalization questions in the test were all better for the forms that used questions in the reading than for the form that used no questions. Also, placing such questions at the beginning of appropriate paragraphs was a little better than inserting them at the beginning of the story, but either of these placements was very much better than placements at the ends of paragraphs or at the end of the story.

Like the investigation of Washburne, the one by Gatto showed a very favorable effect for advance questions. In his study they were used in connection with supplementary materials that enriched significant paragraphs in the text. These materials were not intended to add to the factual content of the text, but to supply background, understanding, and appreciation. There was one selection from 200 to 400 words in length for each of twelve lessons on the colonization period of the United States. Two classes from Grade VII having a total membership of 76 pupils studied these lessons in the text. One of them, the control class, had nothing but day-to-day page assignments, while the experimental class had not only the same assignments but also the above-mentioned supplementary materials headed by advance questions to be answered by the pupils. Both classes were taught by the same teacher. At the beginning of the experiment, all the pupils were given an intelligence test, the Van Wagenen Information Scale *C* 1, and an objective test covering the particular items to be taught in the twelve lessons. The latter test was given again at the end of the experimental period for the purpose of noting the difference in the gains made by the two classes.

When the pupils were paired on the basis of their intelligence scores, the experimental class made a final median score in the history test of 71, as against one of 49.5 by the control class. When paired on the basis of the Van Wagenen test, the experimentals made a final median score in the history test of 72, as against 44.5 by the controls. In a pairing on the basis of the initial history test, the experimentals made a final median score of 75, as against 49.5 by the controls. These remarkable differences must be attributed not only to the effect of advance

questions, but also to the combined effect of advance questions and appropriate supplementary materials.

Training to Answer Questions

Not only are questions useful aids in study, but training in answering them is also valuable. Many pupils fail to answer questions correctly, not because they do not know what is called for; but because they do not know the correct form of the answer. A teacher may ask for a definition; but instead of getting one, he is given an enumeration of objects designated by the term, or a description of them. If the pupil knew the form of a good definition, he would in many cases give it.

The value of training pupils in the correct form of answering questions was investigated by Meeker,[5] who trained an experimental class of thirty pupils in answering six types of questions on American history, and compared their gains with a control class of thirty pupils.

The six types of questions were:

1. Decision for and against, with reasons, *e.g.*, "Do you think the Cubans were justified in revolting from Spain?"
2. Cause and effect, *e.g.*, "What caused the United States to declare war on Germany?"
3. Sense of evidence, *e.g.*, "What evidence do you find that the United States believed in settling disputes by arbitration rather than by war?"
4. Definition, *e.g.*, "Define socialism."
5. Specific comparison, *e.g.*, "Compare an award by arbitration and an award by a court."
6. Illustration, *e.g.*, "Illustrate what is meant by arbitration."

Two weeks of training were spent on each type of question. Some training was general for all types, and some specific for each type. The procedure of the general

[5] Meeker, Harold, *"An Experiment in Teaching Pupils How to Answer Questions."* Master's thesis, University of Chicago, 1926.

training was to read each question twice, understand it clearly, and give numerous examples of it. The specific training varied with each type. In type 1, *decision for or against,* the pupils were instructed to think over both sides of the question before coming to a decision to make sure that the reasons logically supported the decision, and to make clear whether the decision was for or against. In type 2, *cause and effect,* the instructions were to make sure that the question called for was answered, that the facts were correct, that the required facts were brought out, and that no extraneous facts were included. In type 3, *sense of evidence,* the instructions were to see whether the evidence made the question true or false, to be sure that the evidence was real proof, to have proper authority for it, and to be certain that it was not a matter of opinion. In type 4, *definition,* the standard set up was: "(1) name the thing to be defined; (2) put it in its smallest known class; (3) separate it from all others of its class." In type 5, *specific comparison,* the instructions were to compare like things, such as size with size; to make several points of comparison, and always to finish or balance the comparison. The training lasted fifteen weeks, before and after which two similar tests were given, each containing samples of each type of question.

Training in answering certain types of questions greatly improved the ability to answer those types. The results showed that the amount of improvement was far greater in some types than in others. For example, the excess gains in questions calling for definitions, specific comparisons, and illustrations were 44 percent, 35 percent, and 24 percent, respectively, while those calling for a decision for or against, statements of cause-effect relationships, and sense of evidence were only 7 percent, 20 percent, and 7 percent, respectively.

Outlining as a Study Procedure

Outlining is a useful study procedure not only in social science but in many other activities. It forces an individual to analyze the content before him, to look for logical relationships, to discriminate, judge, understand, and evaluate the various statements made; to select the most significant ones, and to express them briefly in clear English. There is a danger, however, that a pupil will write an outline before he is prepared to do so, and that as a result, his outline will contain much irrelevant material, while failing to include the significant points. The reason may be that he does not know how to evaluate, how to pick topic sentences, how to make use of chapter-section and paragraph headings, or how to be consistent in argument. But such deficiencies may be overcome by training. The value of such training for ancient history, geography, and American history was investigated by Barton,[6] and by Dixon.[7]

Barton used about 173 pupils selected from three secondary schools. His procedure was to use groups balanced by means of mental tests, having the experimental group use the outlining procedure, and the control group the usual procedure but no outlining. Before using the outlining procedure, the students in the experimental group were given by their teachers a series of lessons in outlining prepared by the experimenter. The objectives of this training were the mastery of ideas and of the mechanics of outlining in representing perceived thought relationships, and the habit of using the outline as an instrument of understanding and recall. The lessons consisted of

[6] Barton, Wm. A., *Outlining as a Study Procedure.* Columbia University Contributions to Education, No. 411. New York City: Teachers College, Columbia University, 1930.

[7] Dixon, Peryl Claud, *Outlining as a Study Skill in Social Science.* Master's thesis, Colorado College of Education, 1934.

exercises in finding the topics of paragraphs, selecting the best topic for a paragraph from a number of suggested topics, finding the method of developing a paragraph and the devices, such as topic sentences, introductory paragraphs, summarizing paragraphs, and completing skeletal outlines, by means of which an author shows the structure of his thought. A comparison of the results obtained from the experimental and control groups showed that there was little difference between them in the first unit of study but a very marked difference at the end of the second unit. The average of the experimental group was 37.7, while that of the control group was 27.3. The author concluded that, in reality, outlining was one of the fundamental processes of study for the content subjects.

Dixon, working with pupils from Grade IX, concluded that outlining alone was no more effective than other methods for the acquisition of facts; but when used in combination with other skills, its effectiveness was increased. In connection with the last statement we may recall that Germane [8] found that outlining and summarizing were less profitable methods of study than the same amount of time spent in reading and re-reading, but that they were more profitable than reading and re-reading when directed by advance questions. It should be remembered, however, that Germane did not precede his experiment by training his subjects to outline and summarize. The secret of the excellent result obtained by Barton is probably due to the fact that his subjects were carefully trained to do the job.

Values of Evaluating, Outlining, Summarizing, and Answering Questions

That evaluating, outlining, summarizing, and answer-

[8] Germane, Charles E., "The Value of the Corrected Summary as Compared with the Re-reading of the Same Article," *Elementary School Journal,* Vol. XXI (1921), pp. 460–464.

ing questions are not equally valuable in the study of historical materials was shown by Simpson.[9] He used 1,074 pupils from Grades V, VI, and VII. Pairing the pupils into equivalent groups reduced to 606 the number of pupils whose results were used. The same teacher taught both an experimental and a control class. The time, thirty-five minutes, was the same in each, but was distributed differently in the two classes. In the experimental class, ten minutes were given to directed study, ten minutes to class discussion, and fifteen minutes to the recitation. In the control class, all the time was given to the recitation. To discover the value of the best order for the four procedures, each one was used in four different rotations. When the results of the rotation procedures were compared it was found that the value of each of the procedures, from greatest to least, was: outlining, answering questions, evaluating, and summarizing. The most effective order in which to use the methods was: evaluating, outlining, summarizing, and answering questions. Stated more specifically, this means that the pupil should, first, go over the material and pick out the significant topics; second, make an outline of the main points; third, summarize the points; and fourth, answer questions on them.

Intensive Versus Extensive Reading

Another question about technique in reading is whether it should be intensive or extensive. The prevailing custom is to study intensively the condensed pages of one or two texts, but it is possible that a wider reading of more sources would make a larger contribution to the pupil's achievement. The comparative value of intensive

[9] Simpson, R. G., "The Effect of Specific Training on Ability to Read Historical Materials," *Journal of Educational Research*, Vol. XX (1929), pp. 343–351.

and extensive reading in social science was investigated by Good,[10] and by Weaver.[11]

Good worked with both college and high-school students. As measured by the amount of ideas reproduced by each group, it was found that an intensive reading of a small amount of material was just as effective as a more superficial reading of a much larger amount.

Weaver made an experiment upon two classes of twenty-one pupils each, from Grade VII. The class using the intensive method read three accounts of the subject assigned for the supervised-study period of forty minutes and prepared such exercises as imaginary themes, historical discussions, outlines, cartoons, summaries, charts, debates, and tabulations. In the extensive-reading method the students spent the time reading as many accounts as possible but did not prepare any exercises on the reading. Each class prepared outlines for each unit and each had ten minutes of discussion with the instructor on the assimilative material each period. Two units of United States history were taught during the experiment. In the first unit Class *A* used the extensive-reading method, while Class *B* used the intensive method. In the second unit the classes interchanged these methods. The averages of five objective tests upon the materials studied showed that there was quite an advantage in favor of the extensive-reading method for Class *A*, but no difference for Class *B*. The experimenter drew the conclusion that extensive reading was at least as good if not better than intensive reading.

[10] Good, Carter V., "The Effect of Extensive and Intensive Reading on the Reproduction of Ideas on Thought Units," *Journal of Educational Psychology,* Vol. XIII (1927), pp. 477–485.

[11] Weaver, Robert B., "The Relative Value of Intensive Study and Extensive Reading in United States History," *School Review,* Vol. XXXIX (1931), pp. 217–226; also "Extensive and Intensive Methods in History," *Historical Outlook,* Vol. XXIII (1932), pp. 292–296.

Weaver made a second experiment upon two other units, using the same procedures, and found a considerable superiority in favor of the extensive-reading method. He believes, however, that further experiments are needed to establish this as a generalization. The last experiment creates a presumption in favor of extensive reading. In extensive reading there is a danger of losing organization and the mastery of definite concepts, although these dangers can probably be avoided by the skilled teacher. If a teacher lacks the necessary training it would probably be better for him to use a method in which he has confidence and which is best adapted to his conditions.

Supervised Study

Supervised study is widely accepted as a good plan for all content subjects studied in the secondary schools. Its essential features are a definite period for study either immediately before or immediately after the recitation, a specific and clearly stated assignment to be done in this period, a plan or guide to be followed in doing the assignment, and individual help by the teacher, the object of which is to make the student independent rather than dependent. The success of the plan depends upon how each of these features is carried out. There can be no doubt of the advantage of having a special period of study for each subject and of the opportunity to use, during this period, the best known methods of study. Since supervised study does not imply specific methods but only an opportunity to use them, its value must be estimated from the specific methods used. It is, however, a question whether supervised study should precede or follow recitation. Douglass [12] experimented on this point.

[12] Douglass, Harl R., "An Experimental Investigation of the Relative Effects of Two Plans of Supervised Study," *Journal of Educational Research*, Vol. XVII (1928), pp. 239–245.

Ten pairs of classes were used in the investigation: five in history, one in English, three in mathematics and one in science. One class in each pair used the supervised study-recitation order while the other used the reverse order. It was found that in all the history classes and in the English class there were significant differences in favor of the study-recitation sequence. Douglass suggested that this order is helpful in history because of the increased interest and high level of attention following the study. We might add that since the study procedures are much the same from day to day in the social studies, the pupils can help themselves quite well and can study effectively in advance of the recitation, but in mathematics the procedures change so frequently that it is helpful to have them demonstrated in advance of their application.

The Whole Versus the Part Method in Studying Social Science

Should a unit of social science be studied as a whole or should it be broken into parts which are studied separately from day to day? Early investigators of the whole and part procedures, such as Steffens, Pentschew, Larguier des Bancels, and others, found that the whole method was superior to the part for memorizing such materials as poetry and nonsense syllables. Later investigators, such as Pechstein, Winch, and the writer, found results which favored the part method. The writer's studies showed that the economy of each method depended largely upon the individual using it but that the majority of his subjects could learn more economically by following a part procedure. The confusion and forgetting which resulted from the attempt to memorize a large piece as a unit made the whole method uneconomical. It is possible, how-

ever, that in the study of social-science materials, where the emphasis is placed on understanding facts rather than on memorizing them, the whole method would be more advantageous.

The relative merit of the whole and part procedures in the teaching of social science was made the problem of an experiment by Wrinkle.[18] He thought that the whole procedure would give the pupil a better understanding of the material as a unit and of the interrelation of the elements and, consequently, a better ability to recall the various relationships, although he admitted that the actual application of the method might not produce these results. In his experiment, two groups of eighteen pupils each, from Grade VIII, were carefully balanced in age, intelligence, reading ability, test scores in social science, and general scholarship. Each group studied certain units in American history. The steps in the part procedure were: (1) the assignment of the daily unit; (2) the study of the daily unit—twenty-five minutes for finding answers to questions given; (3) developmental period—twenty-five minutes; (4) objective test and discussion. The steps in the whole procedure were: (1) discussion of the entire unit; (2) assignment of the entire unit; (3) study period —the time varying with the ability of the students, bright students being given an opportunity to study related materials; (4) development of the entire unit—the time varying with the length and character of the unit, but in no case longer than the time given to the control class; (5) objective test and discussion.

An important difference in the two procedures was the adjustment, in the part procedure, of the assignments to

[18] Wrinkle, William L., "The Relative Merit of the Whole and the Part Methods in the Teaching of the Social Sciences," *Historical Outlook*, Vol. XXII (1931), pp. 338–391.

the subject matter. The totals of three tests showed a score of 108 for the part procedure and one of 112.7 for the whole procedure—a small but hardly significant difference in favor of the whole method. Other advantages of this method were that it was found more interesting by the students and afforded a better opportunity for directed study and for correlation with English. Weaknesses revealed in the whole method were that the unit might be too long for the pupil to do well and that the pupil might forget most of the material contained in it. To retain the advantages of both methods, Wrinkle recommended a mixed method involving the following steps: (1) discussion of the whole unit; (2) directed study of the unit; (3) assignment of daily units according to the part method; (4) review of the entire unit; (5) test and discussion. This procedure appears to be psychologically sound and should receive the benefit of an experimental tryout.

The important thing is to adjust the size of a unit to the mental grasp of the learner. In a sense the entire history of America is a unit, but no one would advise a pupil to read a complete volume through before beginning its careful study. However, the pupil might very well be taught the main periods of American history and some of the characteristics of each as a sort of preview to the subject. A directed study of the table of contents might help to clarify the main points of this preview. After this, the periods would be considered in order. In the same manner, each period should be introduced by a preview of its main features and subdivisions, and these should then be studied in detail, part by part. After the parts have been studied, their relationship to the whole should again be reviewed and clarified. Such a procedure, if carried out with due consideration of the limited amount that one can learn

during an hour or less, would combine the advantages of both the whole and the part procedures.

The Value of Training in Study Methods

Having discussed the relation of various study methods to achievement in the social studies, it is worth while to consider the value of specific training in these methods. An experiment by Leggitt [14] showed that direct training in the use of study methods brings about great improvement in them. To an experimental group of 42 pupils from Grade IX she gave training in the following working skills: (1) becoming informed about a new book; (2) use of general reference books; (3) reading a newspaper; (4) interpretation of a diagram or chart; (5) interpretation of a picture graph; (6) interpretation of a table of statistics; (7) summarizing; (8) outlining. Four objective tests to measure improvement in these skills were given to the experimental group and to an equated control group of equal size at four different intervals during the semester.

The gains made by the experimental group between Tests I and IV given at the beginning and end of the semester varied from an average of 12.85 for interpretation of a picture graph to an average of 53.65 for outlining. The corresponding gains made by the control group were 6.19 and 6.03. On the whole, those in the experimental group improved their efficiency in the skills trained about 50 percent. The training from which this improvement was derived amounted to three lessons during the semester for each of the eight skills named. These results suggest that it is worth while to use part of the class time for teaching methods of work.

[14] Leggitt, Dorothy, "Measuring Progress in Working Skills in Ninth-Grade Civics," *School Review*, Vol. XLII (1934), pp. 676–687.

Summary

A number of methods applicable to the social studies may be obtained by inference from their success in such other subjects as reading, typewriting, English composition, English literature, and foreign language.

Comprehension of reading material on the social studies may be greatly increased by placing significant questions at the head of the selection.

Training in answering various types of questions increases the ability to answer those types of questions. This is particularly true of questions calling for definitions, specific comparisons, and illustrations.

Outlining is a fundamental process for increasing achievement in the social studies. To make it effective, however, the pupil must be well trained in the process through directed practice with various types of selections.

A combination of evaluating, outlining, summarizing, and answering questions increases achievement in the social studies. First the reader should go over the selection and evaluate the significant points, then outline them, summarize them, and answer questions about them, in this order.

Extensive reading, when directed by a skilled teacher, is probably superior to intensive reading. But adaptation to conditions should be an important factor in determining the selection of the method to be used.

Employing a combination of the whole and part procedures appears to be superior to a strict adherence to either one. It is recommended that the whole procedure be used for an introductory overview of a new unit, and that subsequently the part procedure be used for the mastery of the sections of the unit, and the whole procedure for integration at the end of a unit.

Supervised study is advantageous in providing study periods, definite assignments, individual help, and the use of the most approved methods. In the social studies, it is advisable to have the study period precede the recitation.

Direct training in study methods greatly improves their efficiency.

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CHAPTER 15

Social Studies: Organization by Methods of Presentation

Daily Versus Unit Assignments

Although the methods of presenting the social studies are many, most of them may be grouped either under daily assignments or unit assignments. By daily assignment is meant the assigning of a certain number of pages each day to be recited upon in the usual question-and-answer fashion, with the amount of the assignment adjusted to the time available for study and recitation and to the ability of the students. Opposed to this is the unit assignment, which is determined primarily by the character of the subject matter. It usually contains some logical subdivision and treats of a certain period or movement possessing a unitary character of its own. The unit assignment is the basis of all the newer plans of instruction, including the Dalton plan, the Wisconsin plan, the Morrison plan, the problem approach, the project method, the socialized recitation, and the subject-survey method. Each of these has its devotees as well as a number of points for and against it from the standpoint of the psychology of learning.

In favor of the unit assignment, apart from its application to each of these newer plans, may be urged all the points stated above in favor of the whole method, and against it we may state the points cited in favor of the part procedure. We shall now take up the experimental literature relating to the newer plans for the purpose of finding

out to what extent the claims made for them have been justified or refuted. At present, experiments are insufficient in number and in kind to make final conclusions possible, but the results so far attained are suggestive.

Unit Versus Chronological Organizations

Theoretically, it may be said that the unit organization makes it possible to study whole movements in history and to see the cause-effect relationships involved within the movement, as well as those between the movement and the total development of which it is a part. For example, if the period of the Civil War in American history is studied as a unit, it is possible to study first the conditions leading up to the war, then the actual conflict and its termination, and finally the effects of the war on the conditions that lead up to it and on the subsequent development of the country. On the other hand, if this period is studied chronologically by administrations, the pupil may lose sight of longitudinal movements because his mind is centered upon the details of cross-sections. But while studying the cross-section it is possible to put the emphasis on longitudinal factors.

An experiment relating to the comparative values of the unit organization and the chronological organization in teaching history was made by Deam [1] in the Joliet, Ill., High School. He had two classes of 33 pupils, balanced for chronological age and intelligence, although the class that followed the unit plan was composed of 19 boys and 14 girls while the class that followed the chronological plan consisted of 7 boys and 26 girls. Each class took a course in American history under the same teacher for one semester, at the beginning and end of which it took two

[1] Deam, Thomas M., "Unit Organization versus Chronological Organization in Teaching American History," *School Review,* Vol. XXXVIII (1930), pp. 782–786.

objective tests: the Columbia Research Bureau American History Test and the Joliet American History Test. In the Columbia test the unit class increased its score from 43.4 to 82.5, while the chronological class increased its score from 47.2 to 82.2. In the Joliet test, the unit class increased its score from 26.9 to 44.7, while the chronological class increased its score from 27.3 to 46.4. It is evident that in this experiment no important differences were found in favor of either plan.

The Dalton Plan Versus Daily Recitations

Some experiments have been made on the Dalton plan.[2] This has the advantage of unit organization and also makes provision for individual progress, training in budgeting time, and the development of initiative and group activity in methods of study. On the other hand, its use may cause the pupil to fail because he cannot learn well when left to his own devices. Furthermore, he may be insufficiently motivated because of the failure of the plan to make ample provision for social recognition and oral expression. How the advantages and disadvantages influence the final outcome may be seen from the experiments by Shepard,[3] and by Willard.[4]

Shepard divided pupils from Grade VI into two equal groups by means of an intelligence test. Group I was the experimental group and Group II was the control group during the first two weeks. The procedures were interchanged during the second two weeks. The contract used in the experimental group had three parts: first, "What we are to study," in which was given an outline of the

[2] Parkhurst, Helen, *Education on the Dalton Plan.* New York: E. P. Dutton & Co., Inc., 1922.

[3] Shepard, Edwin L., *Contract versus Traditional Method in Teaching Sixth Grade History.* Master's thesis, University of Pittsburgh, 1928–29.

[4] Willard, Martha, "An Experiment in the Use of Two Methods of Instruction," *Educational Method,* Vol. VIII (1929), pp. 505–510.

main topics in sequential order; second, "How we are to study this unit," in which were given specific directions and questions to be answered; and third, "Things to do," in which were contained assignments for preparing discussions, maps, drawings, and the like. Specific directions were also given for using the contracts, stress being laid upon overcoming irregular study periods and lack of oral expression.

The procedure in the control group included daily oral assignments from the text, study and activity suggestions, assignments of class reports, and some exercises in outlining and summarizing paragraphs. Recitations were conducted on the topics in question-and-answer fashion. Before and after each experimental period objective tests were given to measure the results. In the first period there was a small difference in favor of the contract plan; in the second period, a small difference in favor of the recitation plan. Neither difference was statistically significant. In each period, Group II was superior, indicating that the differences found were not due so much to the differences in the method of teaching as in the abilities of the groups.

Another experiment comparing the Dalton and daily-recitation plans was made by Martha Willard in the schools of Ambridge, Pa., where the instruction has been organized for some years on a modified Dalton plan. Miss Willard selected two classes of 36 pupils each from 411 pupils in Grade VI. They were balanced in age, intelligence, and credits attained in history in Grade V. The experimental period lasted 14 weeks and covered 208 pages of Beard and Bagley's *Old World Background,* which was organized into eight units. Each class had 70 meetings of 35 minutes duration, all work being done in the classroom. At the end of each unit, each class took the identical ob-

jective test. At the beginning and end of the experiment. each class took an extensive objective test to measure the progress made during the period. In the experimental class there was an oral presentation by the teacher and a reading of the content by the pupil at the beginning of each unit. Next, an assimilation sheet on the material of the unit was placed in the hands of each pupil. The pupil received an individual progress test twice each week or oftener, after which he was to study the material which he had not yet mastered. He also prepared an oral talk for recitation day on some phase of the unit that interested him. Finally, he took a test at the end of the unit. In the control class there were daily recitations. The first part of the period was used for recitation and the second part for study. Each assignment was grouped around an average of three topics, but a pupil chose for special study one topic on which he preferred to talk. Each lesson was introduced by having one or two pupils review the main facts of the previous day's lesson. Then the new topics were developed, and finally one or more pupils summed up the points for that particular day. Frequently, Monday was used for socialized review, the children having charge of the class. In the objective test the Dalton class changed its average score from 14 percent in the initial test to 74 percent in the final test; the corresponding scores for the daily-recitation class were 15 and 57.

Following the objective test, a subjective application test, consisting of four problems, was administered to each group. The average grade made by the pupils on the Dalton plan was 62, as against 53 by those having the daily recitations. Each test made a good showing for the superiority of the Dalton plan as conducted at Ambridge, but some allowance should probably be made for the fact that the study was made in Ambridge where the pupils

used the Dalton plan in the regular routine and where the teaching staff was enthusiastic about it. It is possible that the superior gains made by the pupils on the Dalton plan are due to special features of the plan, such as oral presentation of the unit by the teacher and frequent progress tests followed by corrective teaching and study, rather than to the plan as a whole. It would be interesting to know what the difference would be between the two plans if these features were added to the daily recitation.

The Morrison Plan

The above experiments also contain a suggestion as to what we might expect from the Morrison[5] plan, since the procedures used had much in common with the Dalton plan.

Two experiments, one by Funk,[6] and one by Douglass and Pederson,[7] give us experimental results on the value of the Morrison in relation to the daily-recitation plan. Funk taught four high-school classes of 22 pupils a year's course in Problems of American Democracy. Two classes used the Morrison mastery technique and two used the plan of daily recitations. The achievement at the end of the year was measured by a wide assortment of tests such as the true-false, multiple-response, completion, application, and organization types. It was found in these tests that the two methods were equally good and that the pupils could be taught to organize material and to apply their information as well by one method as by the other.

[5] Morrison, H. C., *The Practice of Teaching in the Secondary School*; also Smith, E. T. and Bailey, D. C., *A New Approach to History*. Chicago: Univ. of Chicago Press, 1931.

[6] Funk, M. N., "A Comparative Study of the Results Obtained by the Method of Mastery Technique and the Method of Mastery Technique and Review," *School Review*, Vol. XXXVI (1928), pp. 338–345.

[7] Douglass, H. R., and Pederson, K. L., "An Experimental Evaluation of a Unit Procedure in Teaching American History," *School Review*, Vol. XLIV (1936), pp. 362–372.

The only point of superiority found in mastery technique was that the pupils read more widely and that they preferred it.

In the experiment by Douglass and Pederson the Morrison plan was compared with the study-recitation plan. In the former each unit had a preview, four periods of supervised study, and an hour of discussion. In the latter the assignment was followed by 30 minutes of study and 27 minutes of discussion each day. Each section had work sheets, outlines, study questions, and suggestions for earning extra credit. The essential differences between the two procedures was the amount of time devoted to supervised study. Nine classes took part in the experiment, which continued for 54 days during each of two semesters. The percentage of gain in favor of the unit section varied from —2.1 to 10.1 in the first semester and from —4.1 to 10.8 in the second semester. In each semester the gain was greater for the upper than for the lower halves of the classes. The experimenters concluded that the unit plan was likely to be superior and that it was better for bright than for dull pupils.

Neither of these experiments establishes a definite superiority for the Morrison plan. According to the first experiment, the teacher can accomplish just as much by the daily-recitation as by the Morrison plan; in the second, there is some advantage in the Morrison or unit plan, especially for superior pupils. More experimentation is needed to establish definite conclusions, but these experiments lead us to believe that the Morrison plan at least is not inferior.

Laboratory Plan

In the laboratory plan the pupils learn their social studies from original sources as much as possible; where

these are not available, they use a variety of secondary sources in the library. Collecting pictures, clippings, and books, making models, putting on a pageant, dramatizing, and so on, are important features of the plan and help the student in a definite effort to relive the period studied. These activities are usually directed by written assignments prepared by the teacher. They may be checked either by regular recitations or by some more creative production of the pupil, as a paper or a cartoon. This method has the advantage of realism and the opportunity to create effort, but it also has all the disadvantages of the Morrison plan, and in addition, there is the difficulty of providing sufficient first-hand materials.

An experiment comparing the laboratory and daily-recitation procedures was made by Crawford and Slagle,[8] who tried them out in three subjects: economics, history, and citizenship. In economics there were two classes of 28 pupils each from Grade XII; in citizenship, two classes of 23 pupils each from Grade IX; and in history, two classes of 28 pupils each from Grade XI. In general, the laboratory procedure involved the use of a room equipped with shelves, tables, books, maps, bulletins, and other concrete materials. A definite plan or sequence of lessons was outlined and presented to the class by the teacher. Suggestions about references and sources were also given. The students assembled such information as they could that related to the topics, and spent the class periods either planning where to go for additional material, or working over and arranging what they already had. The teacher was in the background acting as a guide and helper when needed, but the major responsibility was placed upon the students. The students kept notebooks, in which they

[8] Crawford, C. C., and Slagle, Lucile M., "The Use of the Laboratory Method in the Social Studies," *Historical Outlook,* Vol. XXI (1920), pp. 113–115.

wrote up the results of their activities. In the objective tests used for measuring the values of the procedures, the laboratory class in economics earned 88.0 points, as against 85.2 points by the daily-recitation class. The laboratory class in history earned 116.6 points, as against 99.7 points by the daily-recitation class. The laboratory class in citizenship earned 105.6 points, as against 84.7 points by the daily-recitation class.

The differences in favor of the laboratory procedure are reliable, particularly for history and citizenship, and show that this procedure deserves to be used. The experimenters said that it was more interesting, stressed problem-solving, involved actual social behavior, gave opportunity for initiative, put school work on the basis of performance, transformed class time into a period of purposeful activity, gave training in investigation, gave an opportunity for adjusting instruction to individual differences, and made the teacher a friendly helper. On the other hand, they said that it gave an opportunity for an unwise choice of activities and for confusing education with activity, that it might be an uneconomical method of getting information, that the subject matter might be neglected, that manual skill might be overemphasized and that more teaching skill was required to keep activities going smoothly. With all of these possibilities for gain and loss, we may be sure that the method should be left in the hands of persons trained to use it.

The Wisconsin or Differentiated-Assignment Plan

An experiment that compared the Wisconsin plan with the traditional daily-recitation plan was made by Esson and Cole,[9] who used 275 pupils in ten first-class high

[9] Esson, Victor E., and Cole, Robert D., "The Effectiveness of the Contract Method as Compared with the Ordinary Method of Teaching," *School Review*, Vol. XXXVII (1929), pp. 272–281.

schools. The classes were balanced in size, ability, and initial achievement. The pupils, who were from Grades XI and XII, were taught three units of American history for one semester. The quantitative results showed differences from one to nine points in favor of the contract method. None of them were large enough to have statistical reliability, but the chances varied from 16 to 1, to 75 to 1 that the obtained difference would be greater than zero. In this experiment the teachers were untrained in the new method, and the library facilities were in many cases inadequate. In spite of this the teachers favored the new plan.

Harbart's Experiment on the Project Method

An experiment comparing the project and daily-recitation methods in high school was made by Grace Harbart,[10] who used three classes in European History for two semesters, or one year. One class of juniors and seniors had 21 members, one superior class of sophomores and freshmen had 23 members, and one inferior class of sophomores and freshmen had 26 members. Each class had a semester's trial with each method. For each class, the work for each semester was divided into 17 units, one for each week.

In the project method, the work was assigned by a work sheet, which stated the problem clearly, gave a list of references to books, charts, and maps, and suggested special topics for investigation. A definite procedure was followed for teaching each unit. On the first day, the teacher gave a 20-minute talk to introduce the unit and create interest in it. This was followed by supervised study. On the second day the pupils got their materials together.

[10] Harbart, Grace G., *Comparative Value of Teaching European History in High School.* Master's thesis, University of Minnesota, 1930.

On the third, they studied them under supervision. The fourth day was spent in organization and discussion, while on the fifth, there were drills, tests, and such activities as dramatization, debating, essay-reading, and discussion. Two periods a day were given to the work.

In the daily-recitation method, the same units were used as in the project method. Each one was assigned by a sheet which gave the pages in the textbook, outside reading references and a list of the required map work. At least thirty pages a week of outside reading was required. The work of the students of both classes was based on a scheme of points, a certain number being required for each grade. These points depended both on the amount and quality of the work done. The procedures were measured by means of written examinations, which were graded *A, B, C, D,* and *F.*

Class 1 did a bit better with the recitation method, but the higher mark was probably due to the progress normally made in the second semester. Class 2 did much better with the project method, but some of this gain was also due to normal progress during the year. Class 3 did equally well with each method. Allowances must also be made for failure to measure the results by reliable objective tests. It is clear that no conclusions can be drawn in favor of either method. The experiment does show, however, that it is possible to have purposeful activity as well as definite problems in the method of daily recitations. If these are the outstanding features of the project method, it is not surprising that the latter fails to show the superiority claimed for it when these features are combined with other methods.

The outcome of Harbart's experiment suggests that the problem method, which is very similar to the project method, may not have a measurable superiority over the

plan of daily recitations. The principal difference between the problem and the project method is that the problem, instead of being the spontaneous outgrowth of the child's experience, is stated and assigned by the teacher. It also does not limit itself so much to problems requiring some manual construction as the project method often does. The problem is usually but not necessarily selected from some feature of contemporary life, such as immigration, race distinctions, unemployment, poverty, divorce, disarmament, imperialism, tariff, transportation, the repeal or enactment of a constitutional amendment, or the regulation of public utilities. With respect to pupil activity, pupil initiative, and social coöperation, the problem and project methods are practically identical, and if the problem is accepted by the pupil the motivation is just as effective. As in the project method, the experimental outcome will depend upon the degree to which the experimenter can avoid such disadvantages as the waste of time because of lack of direction, the ease of undertaking irrelevent activities, the failure to acquire a coherent organization, and the failure to provide the necessary amount of drill—and replace them by effective motivation, pupil initiative, and pupil activity.

The Problem-Project or Progressive-Education Method

A variation of the project method which is used in an increasing number of schools might be called the problem-project or progressive-education method. Some assumptions underlying this method are that the schools should do more in helping the student to integrate his knowledge from the several subject-matter fields; that the content should emphasize real problems in community life rather than the heritage of the past; that the student should ar-

rive at intelligent decisions through information obtained by himself from a variety of sources rather than base them on prejudice and tradition; that the subject matter should be organized primarily with reference to the unification of the student's personality rather than with reference to inherent logical and formal principles; that the mastery of principles and practices of intelligent living is more important than the memory of specific facts; that educative experience consists of a realistic study of a problem and of a coöperative, creative solution; and that it is more important to form attitudes and habits of creativeness, self-initiative, coöperativeness, and toleration than to emphasize the learning of verbal materials.

The social-study materials, when taught under this philosophy, are selected because they are means of solving some problem or project chosen by students under the guidance of teachers for the stimulation and development of their interests. The reason for choosing any subject is its functional value in solving the problem at hand and not its logical organization in a textbook. Divisions in subject matter are therefore ignored. The methods used are those of investigation, collection of data, interviewing, getting materials from first-hand sources through research, interpreting, and drawing conclusions. Creative and original work is encouraged, the development of independence being considered an important goal in all activities.

The experimental evaluation of this type of instruction cannot be fully made by the usual standardized tests, which are designed primarily for the measurement of intellectual traits and information. To measure other important outcomes, Wrightstone [11] has constructed a test on "Working Skills in the Social Studies," a test of ability to

[11] Wrightstone, J. Wayne, *Appraisal of Experimental High School Practices.* New York: Teachers College, Columbia University, 1936.

organize research materials, a test of ability in interpreting facts in social studies, a "Scale of Civic Beliefs," and a technique for making quantitative and qualitative estimates of such performance factors as initiative, coöperation, and the like. Some of the specific abilities measured by these tests are the abilities to interpret narrative and descriptive materials, to read statistical material, to read various types of graphs, to locate information, to separate relevant and irrelevant materials, to sense the logic of complete ideas, to coördinate and subordinate materials, to outline, and to discriminate between true and false interpretations of paragraphs. By means of these and other tests appraisals were made of the outcomes of the work of matched groups of pupils in experimental and in conventional schools. The results showed that the differences were small in the recall of facts in social studies, in organizing skills, in the application of generalizations, and in recitational activities. They were significantly large and in favor of the experimental schools in working skills, interpretation of facts, civic beliefs, self-initiated activities, and coöperative activities. The experimental schools, therefore, appear to be just as good as the conventional schools in the activities which the latter practice. Besides, they accomplish superior results in desirable social habits, attitudes, and beliefs.

The Backward Versus the Forward Order of Teaching History

In the project method it is frequently necessary to learn historical events in a backward order. For example, if a group of boys decides to study the use of the airplane in transportation, a resulting problem might be its construction, which would be illustrated by constructing a model, but another would be to see the airplane as an improve-

ment over earlier methods of transportation. This would involve the problem of tracing vehicles of transportation back to the human carrier, and raises the question whether historical events can be learned backward as well as forward.

An experiment to answer this question was made by Crawford and Walker,[12] who taught junior high-school pupils two units of six weeks each in transportation and in communication. Group I used the backward method for the first six weeks and the forward method for the second six weeks. Group II reversed the order of these methods. For the first six weeks the topic was transportation, and for the second six weeks it was communication. In the backward method for transportation, topics covered in order were: aviation, horseless carriage, iron horse, oxcart, covered wagon, steamboat, and Columbus's voyage of discovery in 1492. The forward method began with Columbus and ended with aviation, covered the same material, used the same references, and held the students responsible for the same points. At the end of each unit, the same objective test was given to each class. The final test was followed two months later by a retention test.

The final test showed a total of 73.71 points for both classes for the backward method, as against 66.38 points for the forward method. The retention tests showed a total of 73.05 points for the backward method, as against 66.38 points for the forward method. Statistical calculations showed that the differences in favor of the backward method were reliable. The experimenters concluded that this method deserved further trial, declaring that it put more emphasis on modern than on ancient material, gave to the student who dropped out before the end of the

[12] Crawford, C. C. and Walker, Wm. L., "An Experiment in Teaching History Backward," *Historical Outlook,* Vol. XXII (1931), pp. 395–397.

course a historical contact with the present, gave history more of the character of a social science, emphasized the study of causes, stimulated the recognition of relationships between the past and the present, favored the selection of history topics related to the present, captured the pupils' interest, and explained the past more clearly. Although these claims are in need of further justification, the experiment indicates that the backward order of learning history necessitated in many projects is not objectionable.

The Socialized Recitation

The value of the socialized recitation in history was investigated by Bessie Pierce[13] in a controlled experiment conducted at the University of Iowa High School. Two equal classes from Grade XI were taught by two teachers of equal ability, one using the socialized method and the other the method of daily recitations with the usual questions and answers. In the socialized method the assignments were carefully made so as to eliminate questions by the teacher and to furnish the pupils with an outline for carrying on the class discussions. To facilitate discussion the class was divided into two groups, each of which sat around a table with a leader at one end. The teacher remained in the room as an unobtrusive listener, taking part only in case of dispute. At the end of four weeks, the identical factual examination was given to each class. The results obtained show that the socialized class made a grade of 87.4, as against 70.0 by the question-and-answer class. Records of other results showed that the question-and-answer class spent more minutes in oral recitation, that the teacher asked more than ten times as many questions, that the number of recitations by the pupils was

[13] Pierce, Bessie L., "The Socialized Recitation in History," *Historical Outlook*, Vol. XIII (1922), pp. 324–326.

nearly 50 percent greater, that the number of failures in recitation was more than twelve times as great, and that the daily attendance was better. However, the ratio of the number of questions by the teacher to the number of responses by pupils was 39 to 172 for the socialized class and 416 to 226 for the question-and-answer class. These ratios indicate that in the socialized class the activity by the pupils is largely spontaneous and self-initiated, while in the question-and-answer class it is largely forced by the teacher and not related to any delayed purposes kept in mind by them. This difference would be sufficient to account for the higher grades made by the socialized class.

Interpretation of the Experiments on the Newer Methods of Teaching Social Studies

A review of the experiments on the newer methods of teaching the social studies shows that some of them secure excellent results and are worthy of more extensive trial and use. Perhaps the most significant observation is that new methods are worth trying and that such experiments as have been reported show us the way of progress for the future. But a final judgment about their superiority should be held in abeyance for the present. The experiments made so far on these newer methods are too few in number and too limited in scope to make final judgments possible. It is not always clear whether in these experiments we are measuring a method, a teacher, or an experimenter's bias. To rule out such possible subjective factors, we should have more, longer, and more carefully controlled experiments. Not only those methods that have been worked on need further experimentation, but also those that have not yet been put to a careful experimental test. In addition to these methods, there are many specific devices, such as experimental modes of

presentation, use of models, maps, pictures, original sources, field trips, dramatization, drill devices, and work books; explanation of technical terms, lecturing versus reciting, and various forms of organization. So far as experiments have gone we can say that the newer methods are at least as good as traditional ones, that they have many possibilities of superiority, and that the experimental way is the reliable way of proving their superiority.

Summary

Methods of presentation may be grouped into daily assignments and unit assignments. In daily assignments, a certain number of pages are assigned each day to be recited upon by the question-and-answer method. Unit assignments are made primarily with reference to logical divisions in the subject matter. They are characteristic of the newer methods of instruction, such as the Dalton plan, the Wisconsin plan, the Morrison plan, the laboratory plan, the problem approach, the project method, the socialized recitation, and the subject-survey method.

Deam's experiment showed no important differences between the unit plan and the chronological plan of teaching United States history.

In the Dalton plan the student prepares his assignment —usually by writing a paper—in a laboratory in his own way and at his own rate and reports it privately to his teacher for approval. Shepard's experiment in teaching United States history found no superiority in the Dalton plan over the traditional method of daily recitations, but Willard's experiment showed a marked superiority of the Ambridge modification of the Dalton plan over the method of daily recitations.

Experimental results on the Wisconsin or differentiated-

assignment plan suggest enough superiority for the method to justify continued experimentation with it. Experimental results on the Morrison plan are equivocal, one finding it superior to the method of daily recitations and another finding no difference. Its advantage will depend upon the amount of difference between the two procedures introduced by the teacher.

In the laboratory plan the students learn the social studies from original sources, or from secondary ones if the originals are not available, according to a plan devised by the instructor. The object is to relive the part as much as possible. Crawford and Slagle's experiment showed superior results from this plan, but the possibilities of going wrong are so numerous that it should not be tried except by those well trained in its use.

In the project method the student, in coöperation with others, thinks, plans, studies, and constructs for the purpose of attaining an object which has a vital interest to him. The teacher desires spontaneous activity by the pupils and works toward his own elimination as the project nears completion. Harbart's experiment showed no important differences between the project method of teaching United States history and the method of daily recitations. This also may be the experimental outcome of the problem method, which has much in common with the project method.

An experimental appraisal of the problem-project or progressive-education method indicates that experimental schools secure just as good results in the social studies as conventional schools in the achievement measured by the usual standardized tests. Besides, they secure superior results in desirable social habits, attitudes, and beliefs.

Crawford and Walker's experiment showed that a back-

ward order of teaching history was more effective than the usual forward order.

In the socialized recitation there is an effort to learn the social studies by self-activity in the form of spontaneous conversation, which, however, is supposed to follow a plan made out by the teacher. Pierce's experiment showed that this procedure secured results superior to the method of daily recitations.

The most significant result of the newer methods of teaching the social studies is the conclusion that new ways are worth trying; but final judgment of their superiority should await further experimentation. However, the newer methods hold out many possibilities of superiority.

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CHAPTER 16

Social Studies: Individual Differences

In this chapter we wish to study differences in achievement in relation to grade, sex, individual differences within a grade, teaching emphasis, class size, kind of school, teacher, and types of difficulties. Each of these phases of the subject stands not for a single factor, but for a group of factors. For example, types of difficulty may be subdivided into study difficulties, difficulties with time concepts, and difficulties with technical terms. Each of these in turn stands for numerous specific difficulties. The same is true of other phases of the subject.

Retention in Relation to Individual Differences

The relation of achievement in the social studies to individual differences is shown very well in studies of retention such as those made by Brooks,[1] Bassett,[2] and Dietze.[3] The subject of retention is interesting not only because of what it shows about individual differences but on its own account as well. The value of the social studies depends in part on the experiences obtained while learning and in part upon the attitudes, habits, and information retained and which can be used to meet social problems as they occur. It is, therefore, worth while to know the various factors influencing retention.

[1] Brooks, Fowler D., and Bassett, S. Janet, "Retention of American History in the Junior High School," *Journal of Educational Research,* Vol. XVIII (1926), pp. 195–202.

[2] Bassett, Sarah J., "Remembering and Forgetting of Various Kinds of Historical Knowledge by VII B Pupils," *Historical Outlook,* Vol. XXI (1930), pp. 169–172.

[3] Dietze, Alfred G., *Factual Memory of Secondary School Pupils for a Short Article Which They Read a Single Time.* Unpublished doctor's thesis, University of Pittsburgh, 1930.

For our purposes the most important study is the one made by Dietze. His investigation was made for the purpose of determining how much of a short prose article, which has been read once, is retained immediately afterward and after certain intervals up to 100 days, how individuals differ in the amount retained, how good immediate memory is as an index of delayed retention, and how memory is influenced by such factors as mental age, vocabulary knowledge, silent-reading ability, grade in school, chronological age, and sex. His procedure was to have pupils read an article in class under standard conditions and after a prescribed period answer a comprehensive recall test on the facts of the article. Three articles were used, having about 3,000 words each. One of the articles was on radium; a second one was a biography of Sir Richard Arkwright, the inventor of the power loom; and the third was an historical account of the early Germans. 2,062 pupils from the junior and senior high schools of Uniontown, Pennsylvania, took part in the regular experiment. In addition, a control group of 727 pupils was used to discover how many of the test questions could be answered in advance of the reading, how the scores of the three articles were intercorrelated, and how many of the test questions could be answered after the article had been read and the answers looked up in the text. The experimental pupils were divided into six groups, each of which read one article for immediate retention and two for delayed retention. The testing arrangement was such that a group was tested only once for a particular article. This feature eliminated the influence of relearning between the reading and the recall test. The intervals investigated were: immediate, 1 day, 14 days, 30 days, and 100 days. The results for the tests at these intervals, and for the test

by the pupils who looked up the answers are given in Table 19:

TABLE 19

RESULTS BY GRADES SHOWING AMOUNTS REMEMBERED AFTER FIVE INTERVALS FROM ONE READING OF A BIOGRAPHICAL ARTICLE ON SIR RICHARD ARKWRIGHT

(From Dietze, 1930)

Grade	Score on Reading and Looking Up Questions	Percent Remembered				
		Immediate	1 day Interval	14 day Interval	30 day Interval	100 day Interval
XII	73.0	64.8	63.3	32.0	31.3	22.6
XI	70.1	62.7	55.2	32.3	31.5	23.0
X	61.9	57.4	49.7	34.4	37.8	28.7
IX	59.7	50.3	42.4	32.9	25.4	21.9
VIII	61.7	50.0	43.4	28.8	27.6	22.0
VII	54.3	43.9	33.5	37.5	25.9	20.5
Average, VII–XII	63.4	54.6	46.4	33.1	30.3	23.4
Average, treating 63.4 as 100 percent		86	73	53	48	37
Same for Early Germans		89	78	58	50	45

Relation to grade. The first result to notice is that immediate retention increased with grade from an average of 43.9 percent in Grade VII to 64.8 percent in Grade XII. A similar influence of grade was true of retention after 1 day; but after 100 days, the influence of grade had largely faded away. Grade is associated with mental age and chronological age; later we shall see that when these factors are taken out, the effect of grade upon retention is negligible.

The second result to notice is that the pupils in none of

the grades succeeded in answering all the questions even when they had an opportunity to look up the answers. The average percent answered increased with grade, from 54.3 in Grade VII to 73.0 in Grade XII, the average being 63.4. This inability to attain a perfect score is due to inability to comprehend reading material and may be accounted for by one or more of the many factors that influence reading ability. But these scores, as well as those for the retention tests, should be discounted to some extent because of the previous knowledge which pupils had of this topic and because of their ability to work out answers from the context. The pupils who took the tests in advance of the reading showed average scores of 6 percent on the Arkwright article, 13 percent for the article on the Germans, and 15 percent for the article on radium.

Relation to lapse of time. The third result to notice is the relation of the amount retained to the lapse of time between reading and recall. This showed a decrease from an average of 54.6 percent in the immediate test to 23.4 percent after 100 days. Roughly we could say that about one fourth of the facts of the original article were retained after 100 days. What the size of this fraction would be after 300 days or 3,000 days or longer periods is a matter of conjecture, but since the amount retained decreases with the length of time after reading, we must assume that it would slowly approach zero. However, these percentages do not represent the amounts retained of what was learned, for the whole of the article was never learned. If we treat the average score, 63.4, made by all grades when the pupils looked up the answers as the amount learned, then we can say that the amount retained decreased from an average of 86 percent in the immediate test to an average of 37 percent after 100 days.

The rate of forgetting in relation to the length of time

is evident in the table, but to show this, we have drawn the results on a curve in Fig. 9. To show the influence of quality of material, we have drawn the curves, not only for the results from the articles on Arkwright and the

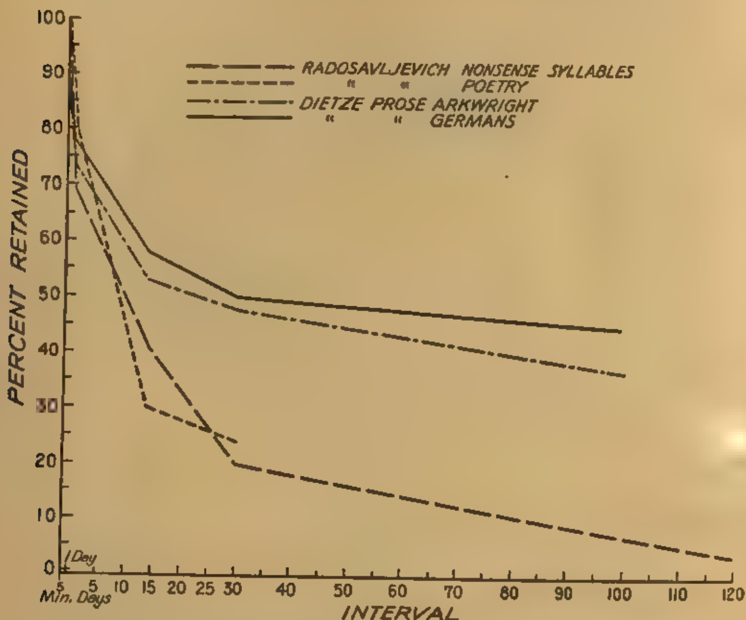

Fig. 9. Curves of retention for nonsense syllables, poetry and prose. (From Dietze and Radosavljevich)

Germans, but also the curves of retention obtained in the experiment of Radosavljevich [4] on nonsense syllables and on poetry. These curves show that the rate of forgetting is very rapid during the first day, that it is fairly rapid during the first two weeks, and that thereafter it is slow. About one fourth is forgotten after one day, but nearly one half of this one fourth is forgotten during the short interval of the test immediately following the reading.

[4] Radosavljevich, P. R., *Das Behalten und Vergessen nach experimentellen Untersuchungen.* Leipzig, 1906.

Comparing the results of Dietze and of Radosavljevich we notice that more was retained of the social-science material after 100 days than of the poetry after 14 days, and this in spite of the fact that the poetry was completely memorized. We also notice that the curve of retention is higher for the poetry than it is for the nonsense syllables. The differences in these four curves—Germans, Arkwright, Poetry, Nonsense syllables—are due primarily to differences in methods of measuring and in the quality of the material. The less meaningful the material, the more rapid and the greater is the forgetting. This brings to light an important factor in learning, namely, that great care should be taken to select meaningful materials.

Relation to quality of material. A fourth result to notice is that the amount retained varies with the character of the material read. This is shown in the last row of the table where the figures show that more is retained after each interval from the article on the Germans than from the article on Arkwright. An inspection of the articles shows that the one of the Germans contained more familiar material, or at least was about more familiar topics—hunting, herding, family life, drunkenness and gambling, huts, villages, clothing, women, and religion—while the one on Arkwright contained a good deal of technical material about spinning, weaving, and manufacturing. Because of this, the article on Arkwright was more difficult and less interesting.

Relation to number of readings. Another factor that influences the amount of retention is the number of times a selection is read. The probability is that most lessons in school are read only once, but serious students read them a number of times, and teachers often advise several readings. It is a practical question how often a lesson can be reread with profit and to what extent retention of the

social studies is dependent upon the number of readings. This problem was investigated by Hunsley [5] in the writer's laboratory. Using the three articles selected by Dietze and six groups of college freshmen and sophomores, she investigated the amount retained immediately after one reading, and two weeks after one, two, three, four, and five readings, respectively. The amount remembered was measured by the percent of 125 multiple-choice questions answered correctly on each article. These questions covered every fact stated in the article. The results showed that the average immediate retention was 66.14 percent. The retention after two weeks was 47.69 after 1 reading, 54.69 after 2 readings, 60.15 after 3 readings, 61.42 after 4 readings, and 66.4 after 5 readings. According to these results retention increases with the number of readings up to five, the largest number investigated, but diminishing returns begin after three readings.

The amounts retained in relation to the number of readings can be considerably increased by allowing the student to reread the article after his first retention test. Hunsley found that students who took a retention test between the second and third readings showed an average score of 80.19 percent in the second retention test, as compared with 60.15 for students who took the first retention test after three readings, and 62.22 for students who read the article twice but did not interpose a third reading between the second and third retention tests. According to these results a procedure of alternate reading and testing is far superior to having the same number of readings and tests in succession.

Relation to individual differences within a grade. The relation of retention to individual differences within a

[5] Hunsley, Yuba, *Retention of Prose in Relation to Number of Readings.* Master's thesis, Ft. Hays Kansas State College, 1933.

grade is illustrated in the recall results after one day obtained from 303 pupils from Grades VII to XII who read the article on Arkwright. They are given in Fig. 10.

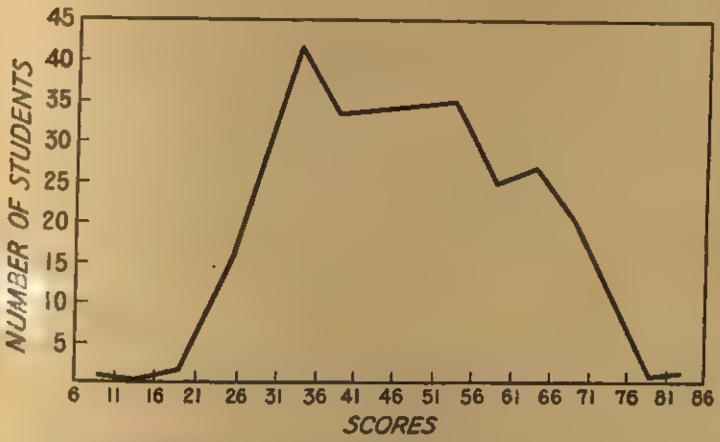

Fig. 10. Distribution of recall scores after one day of ideas in prose read once. (From Dietze, 1930)

Although the average is 46.4, the range of individual differences is from 8.5 to 83.5, within which there is a fairly normal distribution.

Relation to other factors. To discover the influence of other factors, Dietze used the method of correlation. He found that the correlation between immediate factual memory and chronological age averaged .20; between memory for one day and chronological age it was .24; for longer periods the correlations were irregular and mostly negative. These indicate that the influence of age is in itself negligible and that its apparent influence is due to association with other factors such as mental development. The correlation between immediate factual memory and mental age was .55; between immediate memory and vocabulary knowledge it was .58; between immediate

memory and silent-reading ability it was .44; and between immediate memory and grade it was .34. After calculating partial correlations and regression equations Dietze came to the conclusion that mental age contributed about ten times and that vocabulary knowledge contributed about twelve times as much as grade level, and that reading ability contributed about the same as vocabulary knowledge. In short, these statements signify that mental maturity and understanding of relationships designated by words are the important factors in determining the amount of retention from reading. Mental maturity is significant because it is a condition of understanding and organizing facts, which are probably the effective factors.

Relation to sex. Dietze, in agreement with other investigators, found a sex difference in favor of boys for memory of social-science materials. The results obtained from boys and girls paired for age for the three articles that he used are given in Table 20.

TABLE 20

SEX DIFFERENCES IN MEMORY OF FACTS FROM SOCIAL SCIENCE ARTICLES
(From Dietze, 1930)

Article	No. of Boys and Girls Tested	Score		Diff. in Favor of Boys	P. E. Diff.
		Girls	Boys		
Radium....	243	72.1	75.8	3.7	.734
Germans...	220	63.3	64.9	1.6	1.03
Arkwright..	198	54.3	57.0	2.7	.902

The studies made so far on the retention of social-science material are superior to those made in other school subjects, but only a beginning has been made. Other factors that should be investigated are length of lesson, amount, distribution, and form of drill; form of organization, use of concrete and visible materials, story

method of presentation versus the encyclopedic form, and the sensory mode of presentation. As yet a satisfactory drill service for the social studies has not been worked out. There are a number of basic concepts to be mastered, but they cannot be mastered without drill, a fact which authors of textbooks seem not to appreciate.

Causes of Individual Differences

Before instruction can be satisfactorily adjusted to individual differences, it is necessary to understand the causes. Among them we think of differences in ability, in degree of maturation, in sex, in race, in teaching emphasis, in class size and kind of school attended, in the efficiency of teaching, in the mastery of related subjects, and in habits of study. The teacher can do very little about differences relating to native factors, but he can do a great deal about those relating to environmental factors. Consequently we shall discuss the latter, beginning with teaching emphasis.

Differences in teaching emphasis. If a student knows some phases of a subject, the first supposition is that they were emphasized in teaching. The writer has analyzed the results obtained from certain tests for the purpose of finding out more accurately the relation of achievement to teaching emphasis. The tests used were the parts devoted to the social studies in the Entrance and Classification Examination for Teachers Colleges (1932 edition), and the Sones-Harry High School Achievement Tests (copyright, 1929). The first test covers the field of the social studies ordinarily taught in the elementary schools and consists of history (mostly American); terms used in American History, such as Dawes Plan, Industrial Revolution, Recall; famous men, such as Andrew Carnegie, Henry Ford, Ponce de Leon, Briand; dates in American history, such as

1607, 1620. 1776, 1803, 1819, 1898, 1900, 1918, 1919, 1920, 1924; general geography; important facts about world cities, such as an important port and second largest city of India; countries in which are located wonders of nature, such as Carlsbad Cavern, Mount Everest; countries in which originate world commodities, such as asphalt, cocoa, and coffee. The results in terms of percent of items correct are given in Table 21.

TABLE 21

MEDIAN PERCENT OF ITEMS CORRECT IN ENTRANCE AND CLASSIFICATION EXAMINATION FOR TEACHERS COLLEGES TESTS IN GEOGRAPHY, CIVICS, AND HISTORY. DISTRIBUTED ACCORDING TO KIND OF INFORMATION

(222 Entering Freshmen, Fort Hays Kansas State College, 1932)

Kind of Information	No. of Items	Percent Correct
Civics	26	84.30
History, mostly American	55	50.47
Terms in American history	16	76.00
Famous Americans and others	25	49.60
Dates in American history	11	33.00
Geography, general	67	64.90
Important facts about world cities	15	58.30
Countries in which wonders of nature are located	8	12.50
Countries in which world commodities originate	10	27.18

Table 21 shows that in the social studies taught in the elementary schools, these freshmen made comparatively good scores in civics and general geography, but very poor ones in the tests on nature wonders, world commodities, and dates in American history. In fact, in these three tests the most frequent score was zero. The tests on American history and famous Americans show that only about one half of the items were correctly known.

The Sones-Harry test covers the high-school field. The part on the social studies includes the ten divisions named

in Table 22. These tests were given to 219 entering freshmen in the Fort Hays Kansas State College in September 1932. The median achievement in the Sones-Harry test was somewhat above the published norms. In the other test, the norms were not available, and so no comparisons can be made. The fact that these students are up to the norm in the Sones-Harry test is significant, for it indicates that the achievement of this group is typical of what is likely to be found elsewhere.

Table 22 shows that in the social studies taken in high school achievement is comparatively high in civics but very low in famous characters of world history, place geography, names associated with economics, events in American history, and dates involved in the background of American civilization. The most frequent score in these tests was zero or nearly zero. Out of 222 students, 95 or nearly one half could not identify any one of the following: Aristotle, Augustus Octavius, Bismarck, Confucius, Darius, Justinian, Peter the Great, Pitt, Voltaire, and Wycliffe. More than half could not identify the following names associated with economics: Dawes, J. L. Lewis, Malthus, mercantilist, or G. B. Shaw. That is, they did not know these names by the descriptions given in the test. For example, they did not know Dawes as "the co-author of the plan which arranged the present settlement of the German indemnity payments," or G. B. Shaw as "a leader of the Fabian Socialists who believes in education rather than in political action." The events in American history to be located by periods, the dates of which were given if the period occurred after 1789, were: prohibition amendment, first practical use of the automobile, Louis XIV and England's struggle for supremacy, first locomotive used in America, Bacon's Rebellion, the First Hague Conference, Sherman Anti-Trust Act, Kentucky

and Virginia Resolutions, migration of Mormons, Lewis and Clark expedition, military expedition against Villa, Bulls of Demarcation, invention of magnetic telegraph by Morse, opening of Atlantic Cable, and prohibition of slavery in Northwest Territory. The median percent of correct period location for these was only 24.13.

TABLE 22

MEDIAN PERCENT OF ITEMS CORRECT IN SONES-HARRY HIGH SCHOOL ACHIEVEMENT TEST, PART IV, SOCIAL STUDIES. DISTRIBUTED ACCORDING TO KIND OF INFORMATION

(219 entering Freshmen, Fort Hays Kansas State College, 1932)

Kind of Information	No. of Items	Correct Average
Civic information (group 1.)	10	68.50
Civic information (group 2.)	10	70.40
Famous Americans	10	45.00
Background of American civilization:		
Persons	5	52.10
Dates	5	36.70
Influences	5	44.80
Events in American history	15	24.13
Famous characters of world history	10	12.35
International affairs	10	50.35
Place geography	10	30.87
Names associated with economics	5	19.05
Economic vocabulary	10	40.50

The results given show the variation of the group in relation to the character of the fact, a condition that is assumed to be due to teaching emphasis. They show that the group has covered certain subject matter in the social studies and that it retains scattered bits of information about one thing or another, but that this information has little organization and is not related to any objective or vital purpose. Since the tests are informational they do not reveal the student's attitude toward social problems and institutions or what habits of skill he has in dealing

with them, but if the informational objective, which the schools are best equipped to give, is poorly realized, we may assume that achievements in regard to habits and attitudes are far worse. With respect to subject matter marked weaknesses are shown in chronological judgment, locational geography, European or world history, and economics. Although such information can be used for the organization of courses for particular groups, the deficiencies in the individual whose development is the object of the teaching process are still more important.

The relation of achievement to class size and kind of school. The influence of class size on achievement in the social studies was investigated by Goldizen[6] and by Bloomfield,[7] while that of the kind of school was investigated by Van Wagenen.[8] Goldizen studied the achievement of one class of 70 pupils in junior high-school history in comparison with two classes of 35 pupils each of equal ability, as measured by a group intelligence test. In three units of work covering a one-semester course in American history, she found that the smaller classes were considerably superior to the large class in the first unit, equal in the second unit, and noticeably inferior in the third unit. She concluded that large classes suffer no disadvantages because of size.

Bloomfield compared the achievement of a class of 55 in senior high-school American history with that of an equally able class of 30 students who were taught in the same room and by the same teacher but at a different period of the day. The averages of a series of twelve ob-

[6] Goldizen, Mae, "A Study of Class Size in Junior High School History," *School Review*, Vol. XXXVIII (1930), pp. 360–367.

[7] Bloomfield, L. S., "Class Size in Senior American History," *Historical Outlook*, Vol. XXII (1931), pp. 107–108.

[8] Van Wagenen, M. J., *Comparative Pupil Achievement in Rural, Town and City Schools.* Minneapolis: University of Minnesota Press, 1929.

jective tests showed equality in achievement for the two classes. The investigator believed that large classes favored the development of self-reliance on the part of the pupil as well as economy from the administrative point of view.

Van Wagenen gave standardized tests in the principal school subjects, including history and geography for Grades VII and VIII, to 2,500 pupils in eight-month rural schools, 1,500 pupils in nine-month rural schools, and approximately 2,000 pupils in four classes of town and city schools. The most striking result was the superiority of the pupils in nine-month rural schools over those in eight-month rural schools. But the city and town schools were also superior to the nine-month rural schools. However, the small city schools were about a half year ahead of the large city schools in history and geography. In both subjects the boys were nearly a year ahead of the girls. The exact cause of the differences in relation to the kind of school is not given, but we may guess that an important factor is the training and abilities of the teachers employed by the respective schools.

Achievement in Relation to the Teacher

That the teacher is an important factor in achievement in the social studies is shown in an investigation made by Eleve Michell,[9] who reported on the scores and intelligence quotients of pupils in three schools taught by seven teachers, the course of study and the objective tests being identical for all pupils. From these results the writer has calculated the medians which are given in Table 23.

Other things being equal, teachers *B* and *C* should have received results equal to *A*'s and Teachers *P* and *Q* should have achieved results equal to *R*'s, while Teacher *F* should

[9] Michell, Eleve, *Teaching Values in New-Type History Tests*. Yonkers, N. Y.: World Book Company, 1930.

have achieved the poorest results of all. The results in School *Z* should have been better than those in School *X*, and those in *X* should have been better than those in *Y*. But as a matter of fact, Teacher *F* in School *Y* secured the

TABLE 23

MEDIAN SCORES MADE IN THE SAME TESTS BY THE PUPILS OF DIFFERENT TEACHERS

(Number in Parentheses RepresentNumber of Pupils Taught by Teacher)

School	Median I. Q. of Pupils	Teacher	Score	
			Test 3	Test 4
X	115	*P*	64 (60)	64 (62)
		Q	58 (75)	63 (72)
		R	68 (57)	70 (46)
Y	101	*F*	62 (99)	67 (99)
		A	64 (31)	58 (29)
Z	122	*B*	56 (87)	48 (86)
		C	44 (90)	52 (94)

best results, and School *X* secured better results than School *Z*. Such variations, under these conditions, are due largely to differences in teaching ability.

Achievement in the Social Studies in Relation to Achievement in Other Subjects

The Sones-Harry Test, an achievement test in elementary-school subjects, an English test, and the American

Council Psychological Examination were given to about 220 entering freshmen at the Fort Hays Kansas State College in the Fall of 1932. From this team of tests, ten tests were selected for correlation with Part IV, Social Science, of the Sones-Harry test. These tests give us some idea of how achievement in social science is related to achievement in other tasks and subjects.

From these results it appeared that achievement in elementary history is the best index of achievement in the high-school social studies, the correlation being .74. Next to these is achievement in natural science, English, and vocabulary. All of these have a correlation of about .61 with achievement in the social studies as measured by the tests used. Next to these come achievement in high-school mathematics, English form or mechanics, and English literature, which correlate about .55 with social studies. Next in order come ability in silent reading and intelligence, which correlate about .45 with social studies. These correlations appear to be in proportion to the number of common factors between social studies and the related test.

Study Difficulties

Since much of the material in the social studies is reading matter, the achievement of the student is influenced by his ability to locate information and by his methods of study. It would also vary with his ability to master difficulties inherent in the subject matter, such as technical terms and time relations. Difficulties in locating information have been investigated by Dutton;[10] those relating to methods of study, by Wirth [11] and by Van Bibber;[12] those

[10] Dutton, Wilbur H., *Difficulties in the Location of Information of Junior and Senior High School Social Science.* Master's thesis, Colorado State Teachers College, 1933.

[11] Wirth, Franklin P., "Classroom Difficulties in the Teaching of History," *Historical Outlook,* Vol. XXII (1931), pp. 115–118.

[12] Van Bibber, Lena C., "An Explanatory Study of Specific Classroom

relating to technical terms by Meltzer;[13] those relating to time concepts by Anderson.[14]

Difficulties in locating information. Dutton investigated the difficulties of students in locating information in junior and senior high-school social science. Among the conclusions reached were the following: (1) the social-studies pupils have only a very elementary knowledge of the index of a book, printed parts of a book, the encyclopedia, and card catalog; (2) pupils are handicapped in locating information accurately and quickly; (3) the important skills and abilities used in the location of information have not been acquired by incidental teaching, and the reading program has not provided for their teaching; (4) the schools are turning out pupils who are wholly unprepared to locate information for themselves. If these conditions are typical, it is clear that the locating of information should be systematically taught in the social studies—if not in the grades, then certainly in junior high school.

Difficulties in methods of study. In his investigation of study difficulties, Wirth first collected a list of 71 difficulties from 30 graduate students. These were then arranged into a check list and sent out to teachers of history. A total of 1,417 teachers from 38 states and the District of Columbia reported. The writer has reclassified these into three groups: those relating to equipment, those relating to study habits, and those relating to teaching. Out of

Difficulties in Teaching of History and Other Social Studies," *Second Yearbook: the National Council for Social Studies.* Philadelphia: McKinley Publishing Company, 1932, pp. 7–97.

[13] Meltzer, Hyman, *Children's Social Concepts.* Columbia Contributions to Education, No. 192. New York: Teachers College, Columbia University, 1925; also "Talkativeness About, in Relation to Knowledge of Social Concepts in Children," *Pedagogical Seminary,* Vol. XXXIII (1926), pp. 497–507.

[14] Anderson, Howard R., *The Mastery of Time Concepts by Students in the Junior High School.* Master's thesis, University of Chicago, 1928.

the 71 difficulties reported, 53 were mentioned by 100 or more teachers. The remaining 18 are of minor importance. Of the 53, 6 related to equipment, 25 to study habits, and 22 to teaching. Those relating to equipment complained of insufficient books, maps, atlases, museums, and stereopticans. Those relating to teaching referred to conducting work in current events, organizing daily lessons into parts of larger units, getting students' points of view, collateral reading, too much talking by students (bluffing), getting clear objectives and the like. Those referring to study habits were the following in order of frequency:

1. Too many topics for time available.
2. Student tries to remember rather than understand.
3. Student does not know how to study.
4. Student accepts interpretation of textbook.
5. Student sees no reason for studying history.
6. Lack of home stimulation and interest.
7. Deficient training in history.
8. Student fails to make comparisons of events, personages, causes, movements, and results.
9. Difficulty in getting student to make a summary of the lesson.
10. Student fails to see important relations.
11. Student fails to see relation of cause and effect.
12. Student accepts the interpretation of the teacher.
13. Student fails to see large topics or movements.
14. Student fails to see relations of individuals and events.
15. Deficient training in geography.
16. Student fails in English (oral and written).
17. Student fails to make proper outlines.
18. Student memorizes mere detail.
19. Difficulty in testing attitudes.
20. Deficient elementary training.
21. Student fails to get sense of time.
22. Student fails to understand spirit of time involved.
23. Student fails to get facts in their proper setting.
24. Student follows his own prejudices.
25. Student fails to see historical characters as real.

Some of the foregoing difficulties, especially those referring to the perception of important relations, no doubt lie

within the student, but most of them appear to be due to faulty teaching. Even the failure to perceive important relations may be due to the fact that they were not pointed out to the student. The presentation of too many topics is a consequence of the encyclopedic character of textbooks. Trying to remember rather than understand may be a result of the fact that most of the questions asked are directed to memory. Not knowing how to study, seeing no reason for studying, failing to make comparisons, failing to see large topics, failing to make proper outlines, and failing to sense spirit of the time may all be due to lack of instruction in these matters. Some of the remaining difficulties have been topics of special investigation. For example, Meltzer's[15] study of the development of children's social concepts related directly to difficulty 10, "student fails to see important relations." Anderson's[16] study of the mastery of time concepts in the junior high school related to difficulties 21 and 23, "student fails to get sense of time," and "student fails to get facts in their proper setting." Thurstone's work on the measurement of attitudes related to difficulty 19, "difficulty in testing attitudes."

Difficulties with technical terms. One difficulty in every subject is to get a clear idea of the technical terms used in that subject. The first step is to find the technical terms used in a subject, then to investigate the meanings which school children acquire about these terms. Such was the procedure followed by Meltzer. He secured a list of the important terms used in critical literature dealing with social problems, then held personal interviews with children to discover what ideas they had of them. The terms were: democracy, socialist, big business, capitalist,

[15] *Op. cit.*
[16] *Op. cit.*

imperalism, an industrial country, an interdependent world, Americanism, wage earner, prime minister, balance of power, standard of living, liberalism, militarism, conservation of natural resources, a constitutional government, a centralized government, trade unionism, labor union, radicalism, aristocracy, division of labor, anarchist, conservative, foreign trade, open shop, monopoly, public opinion, large-scale production, patriotism, personal rights, and industrial revolution.

A total of 333 pupils were interviewed about their understanding of these terms, of whom 106 were in Grades IV, V and VI (all but 2 in Grades V and VI); 115 were in Grades VII, VIII, and IX; and 112 were in Grades IX, X, and XII. There were 82 definitions given for "democracy" and 87 for "socialism." Each of the other terms investigated received from 42 to 101 definitions each. The meanings for the term "democracy" varied from single instances of such definitions as "Free government—do everything except crimes," "People fight for country," "People should not fight," and "Trying to get money," to "Government by the people," by one fifth of the children in the grades and one half of the children in high school. Similarly, the meanings given for "socialism" varied from single instances of "Social service person," "Party for adults," "Radical and fiery person," to "Wants equal distribution of wealth" by about 6 percent of all the children and to "Does lots of social duties, goes to parties, etc.," by 32 percent of the children in the grades and 7 percent of the children in high school. Some of the frequent definitions given for other terms were "Capital of state or country," for capitalist; "Goes to foreign country," for prime minister; "Remaining in power, after work, or war," for balance of power; "To give charity freely," for liberalism; "High-rich people, society, wealth," for aristocracy;

"Saves things," for conservatives; "Door open for business," for open shop; and "Strike," for industrial revolution.

These meanings given by the pupils show that getting clear ideas of important social concepts is a real difficulty in learning social science. This difficulty is partly corrected by advancement through the grades, as is shown in the results obtained by Meltzer. He allowed eight points for every correct definition, and since there were 31 terms the maximum score was 248. The average scores for these terms changed from 27.4 for Grade V to 158.91 for Grade XI. Another factor that influences the scores is the kind of social-science material used. Meltzer found, for example, that pupils from Grade VIII who studied Rugg's Social Science Pamphlets made much better scores than did high-school seniors who studied conventional materials. This shows definitely that the concepts of the social studies can be taught if attention is given to them.

Difficulties with time concepts. In Anderson's study of the mastery of time concepts in American History, 22 common dates were used in the form of a multiple-choice test, which was given to 229 pupils in Grades VII, VIII, and IX. The results showed an increase in the percent of accuracy from 30 in Grade VII *A* to 44.2 in Grade VIII *A*. There were, however, wide variations in the accuracy of particular dates; for example, from 7.8 percent for 1823 (Monroe Doctrine) to 93.5 for 1492 (Columbus's discovery of America). The date July 4, 1776 (Declaration of Independence) had an accuracy of only 45.5 percent. The tests which required pupils to place events in their approximate time setting such as their century or quarter of a century showed that the pupils did not know how to name a century. Their judgments in this test were even less accurate than they were in tests requiring knowl-

edge of the exact date. Related dates that occurred rather closely together, such as 1765 (Stamp Act Controversy), 1775 (Battles of Lexington and Concord), 1776, and 1783 (End of Revolution), gave unusual difficulty.

Anderson also studied his results in relation to mental age and sex. He found that mental age had little or nothing to do with knowledge of date-events but that the boys had from 14 to 29 percent better scores than the girls. That the mastery of date-events is largely a matter of drill is indicated by the fact that five repetitions of a test of 14 events given to 54 students throughout a period of one and one-half years showed an increase from 222 correct identifications to 338, the highest possible score being 756. This indicates that one remedy for the difficulty of placing events in their correct time setting is a series of well-spaced drills.

The foregoing analysis of causes of individual differences leads to the conclusion that the causes are very complex. Since the studies dealt principally with groups it is evident that many causes peculiar to individuals were not revealed, but as far as they go the experiments indicate that the numerous differences in instruction, methods of study, and study difficulties would produce corresponding differences in achievement. The next question is how to adjust the instruction to these differences.

The Adjustment of Instruction to Individual Differences

Because of the wide differences in achievement and in types of difficulty, it is evident that the instruction must be individualized. This may be done in three ways, namely: using the standard individual plans, using homogeneous grouping, and using the case-study method.

Using standard individual plans. The standard indi-

vidual plans provide an opportunity for meeting individual needs. The Wisconsin plan provides assignments graduated in difficulty to meet different levels of ability. The Dalton plan allows each individual to work out his assignment in his own way. An essential feature of the Winnetka plan is its requirement that the individual shall work at the correction of his own weaknesses. In the project method an effort is made always to have each individual carry out that part of the project which he can do best. The essential purpose of the supervised-study plan is to give the teacher an opportunity to help each individual with his peculiar difficulties. If these plans fail to provide for the needs of individuals, it is because of the teacher's failure to make use of their provisions for this purpose. Even if a teacher does not follow one of the newer plans, he still can do much to take care of individual needs if he studies them and makes an effort to meet them. To study them, it is necessary to observe how the individual differs from others not only in his achievement but particularly in his errors and in his interests. Having discovered them, it is necessary to take time to make individual assignments. The failure of the traditional procedure to take care of individual needs is due not so much to the method as to the habits of the teacher.

Homogeneous grouping. Ability grouping offers a partial solution to the problem of individual differences, but not a complete one. In a study made by Shafer,[17] he shows that sectioning alone is inadequate—that there should be individual diagnosis, special attention to reading, and personal interviews. However, a great deal can be done by group adjustments.

[17] Shafer, Hugh M., *Evaluating Coöperative Teaching in the Social Studies.* Master's thesis, University of West Virginia, 1935.

An example of adjustment by means of grouping according to ability was found in the South Philadelphia [18] high school. Here the pupils were divided into four groups which may be called very inferior, inferior, superior, and very superior. The very inferior were thought not to be equal to graduation from high school. They received vocational and civic training in such subjects as filing, typing, office work, and the elementary sociology relating to the worker, including labor and wage problems. The group met three times a week and did all its work under supervised study. The inferior group had possibilities of graduation from high school. It studied what was called "Slow History." Although the students were in the senior high school, they used junior high-school texts. The assignments were worked out very explicitly on tool sheets. Some elective reading on biography, on social customs, and in historical novels was required.

The superior group followed the regular course, using guide sheets to help organize the materials. Those who did not work did elective reading on related problems. The very superior group omitted the class work and attended only the conferences planned for them. They followed the project method, for which they did their own collecting, selecting, and organizing. In this organization we see one advantage of homogeneous grouping—the possibility of finding materials and methods that are suited to the needs of the individual. The first group could not carry out the projects of the fourth and be put upon their own responsibilities, but they could learn filing and typing under careful supervision. The inferior group would have had much trouble with regular high-school texts but it could understand the junior high-school texts when the

[18] Stern, Anna L., "An Attempt to Individualize Instruction," *Historical Outlook*, Vol. XXI (1930), pp. 329–332.

assignments were carefully made. Within each group there were, no doubt, wide differences which these procedures did not take care of, but a partial adjustment is far better than none.

The case-study method. How the case-study method is applied to social-science pupils is illustrated in its practice in the University of Chicago High School as described by Kimmel.[19] According to him the case-study method involves three steps: (1) locating the maladjusted pupil, (2) diagnosing his difficulties, and (3) remedying the difficulties.

The maladjusted pupil may be located by gaps in previous training, poor showing in test scores and in conferences, poor study habits, difficulties in written work, and unusual personal traits. Diagnosis of the difficulties includes two sorts of data, objective and subjective. The objective data include scores on psychological tests, subject-matter tests, personality scales, learning curves, and times required to complete specific tasks. The subjective data include a record of personal observations by the teacher, including habits of study, daydreaming, spirit in work, attitude toward the course, instructor, and the class, and possible abnormal responses and abnormal attitudes. The remedial work is based upon the diagnosis and always takes the form of individual instruction. The pupil is given a series of jobs to do. Each one is carefully checked when it is completed, and the next one formulated in the light of the results accomplished in the one just finished. Everything is done to establish friendly relations between pupil and teacher, and the pupil is impressed by the fact that his success depends principally upon his own attitudes, desires, and efforts.

[19] Kimmel, W. G., "The Case-Study as a Method of Solving Pupil Difficulties in the Social Studies," *Historical Outlook*, Vol. XXII (1931), pp. 118–121.

The case studies at Chicago bring to light four groups of causative factors: (1) reading difficulties, (2) poor study habits, (3) difficulty in handling the tools necessary for doing the written work in the social studies, and (4) peculiar personality traits, such as chronic cases of inhibited responses and distorted attitudes of long standing.

The diagnostic phase of the case-study method may even be applied with profit to normal or average individuals. If it is, we become aware of the fact that normal individuals may be lacking in many things. An analysis of the results of the Sones-Harry test obtained from Milan may be taken as an illustration.

Milan is nineteen years old and has had social studies for five semesters in high school; his total score is 32, and the norm for five semesters is 28. He scores 2 out of a possible 10 in "economic vocabulary." He indicates that "the organizer who is at the center of every business" is "the unearned increment," that "the secret destruction of machinery or of the product in order to injure the employer" is "organized labor"; that "the noninterference by government in business" is "sabotage"; and that "depression, recovery, business property, financial strain, and industrial crises" are steps in "—— large scale production." The score for "names associated with economics" is zero. Five of the ten items in "place geography" are correct. Five of ten items on "international affairs" are correct. None of the ten items on "famous characters of world history" are correct—Milan indicates that Confucius is the author of *The Republic*, that Gladstone was the ruler under whom the earliest known law code was formulated, that Bismarck was the Roman Emperor who granted toleration to the Christians by the Edict of Milan, and that Peter the Great was the famous prime minister of England who established free trade, and so forth. Five of the fif-

teen "events in American history," three of the fifteen on the "background of American civilization," four of the ten "famous Americans," and eight of the thirty items on "civic information" are correct. In the last test, he indicates that the most important public officer of the state is the government, that the officer who advises the president in the conduct of foreign affairs is the attorney-general, and that the body that has the power to regulate the relations between man and wife is the people.

Milan is an average high-school graduate; he has had an average amount of the social studies and his scores are slightly better than the norm, but his deficiencies, as well as those of the group, cause one to raise the question whether being up to the norm in the social studies implies adequate training for the discharge of the duties of citizenship. That Milan's deficiencies do not present an isolated case is indicated in an extensive study made by Melbo[20] of the information possessed by high-school seniors on contemporary problems. From an analysis of books and clippings he found 532 problems and 227 issues in contemporary affairs. A test of 850 items administered to 4,348 seniors in 38 high schools showed that the seniors had some definite information on about one third of the issues and problems, lack of information or misinformation on one third of the problems and issues, and definite misinformation on the remaining third. Melbo concluded that high-school graduates are decidedly lacking in information about current affairs and inadequately prepared to contribute to the solution of contemporary problems.

The studies made so far show that rapid strides are being made in dealing effectively with the individual pupil,

[20] Melbo, Irving R., "Information of High-School Seniors on Contemporary Problems," *Social Studies*, Vol. XXVII (1936), pp. 82–86.

but the end is not yet near. Meltzer's study showed that few pupils reach a clear understanding of basic concepts. This raises the question of the amount of mental maturity necessary for the mastery of these concepts. At what mental level can they be presented most economically? A study should be made that will give us an answer to this question. Or, is this failure to reach clear conceptions of important terms due to failure to teach them? We should find out whether this is so.

Although Wirth's study gives us important information on pupils' difficulties, the latter are limited largely to the classroom and are some distance removed from the individual pupil. A study should be made which will find the individual pupil's difficulties by the personal-interview method. Kimmel's case-study method is a suggestive procedure for pupils who have chronic difficulties, but it is in need of considerable refinement. It is doubtful whether a teacher of the social studies should handle such cases. So many mental and personality difficulties are usually involved that only a clinical psychologist should diagnose the case and prescribe remedies. One of the greatest needs for dealing with individual pupils is a set of adequate diagnostic tests.

Summary

Achievement in the social studies differs in relation to grade, individual differences within a grade, teaching emphasis, class size, kind of school, teacher, and types of difficulty.

The relation of achievement to many individual differences is well illustrated in studies of retention, which are also interesting on their own account.

In relation to grade, the amount retained of an article

which had been read once varied from 43.9 percent in Grade VII to 64.8 percent in Grade XII.

In relation to lapse of time, the average amount retained for all grades (VII–XII) varied from 54.6 immediately after reading, to 23.4 one hundred days later. Grades VII, VIII, and IX retained smaller amounts, while Grades X, XI, and XII retained larger amounts.

In relation to quality of material, the more familiar selections had higher percentages of retention than the less familiar. This suggests the importance of using meaningful material. An illustration of this is the fact that a pupil retains as much from one reading of a meaningful social-study article after 100 days as from a completely memorized row of nonsense syllables after 14 days.

In relation to number of readings, the percent of retention increases up to three, but more readings are unprofitable because of diminishing returns.

In relation to individual differences within a group, the amount retained varies from 8.5 to 83.5 percent, the mean being 46.4.

Correlation studies show that mental maturity and knowledge of words are important factors in retention. Their importance is probably due to their relation to comprehension.

In relation to sex, retention in the social studies is in favor of boys.

Among the causes of differences in achievement are differences in ability, maturation, sex, teaching emphasis, class size, kind of school attended, efficiency in teaching, mastery of related subjects, and habits of study. For the teacher, those relating to environmental factors are most important.

The relation of achievement in the social studies to teaching emphasis may be seen in the results obtained

from an objective test when achievement is classified according to kind of information. One such test showed that the percent of items correct varied from 12.5 for information concerning wonders of nature to 84.3 percent for information about civics. In a second test, the percent of items correct varied from 12.35 percent correct for information about characters of world history to 70.4 percent for information about civics.

The relation of achievement to class size is indefinite. Some teachers get better achievement in small classes, while some think that class size within certain limits is unimportant.

The relation of achievement to the kind of school attended appears in Van Wagenen's study. Nine-month rural schools secure better achievement than seven-month rural schools, but small city schools get better achievement than either rural schools or large city schools.

The relation of achievement to teaching efficiency is indicated by the fact that some teachers get 50 percent better achievement than others, as measured by tests, even when the better teacher has the poorer pupils.

The relation of achievement in the social studies to achievement in other subjects is shown by correlations which vary from .74 with elementary history to .45 with silent reading.

A group of important causes of variations in achievement in the social studies is found in the study difficulties of pupils. These relate to difficulties in locating information, in methods of study, in mastering technical terms, and in mastering time concepts.

High-school pupils are very inefficient in using an index, encyclopedia or card catalogue, and as a result cannot locate information accurately and quickly.

Among the more frequent difficulties in study habits,

according to the investigation of Wirth, are (1) too many topics, (2) trying to remember instead of understand, (3) accepting interpretation of textbooks, (4) seeing no reason for studying, (5) not knowing how to study, (6) deficient training in history, (7) inability to summarize, (8) not seeing cause-effect relations, (9) not seeing important relations, and (10) accepting the interpretation of the teacher.

Meltzer's study of the development of children's social concepts showed that the mastery of social concepts is a real difficulty for students in the social studies. Only a small percent of students either in the grades or in high school acquire clear and correct ideas of the important concepts. For the most part their ideas are hazy and wide of the truth, although they grow in accuracy with the advancement of the pupils through the grades. An important aid in giving pupils clear concepts is the study of proper materials.

Anderson's study showed that the mastery of time concepts is another real difficulty for students of the social studies. Junior high-school pupils know an average of less than 45 percent of the important dates in United States history; there are larger variations with respect to the date. These pupils do not know even how to name a century. Well-spaced and systematic drills should bring about a large increase in the accuracy of such information.

Among the important methods of adjusting instruction to individual differences are using the newer methods with emphasis on the opportunities for individual instruction, traditional procedures with emphasis on individual instruction, homogeneous grouping, and the case-study method. The important steps in the last are accurate personal history, detailed diagnosis, and individual teaching adapted to conditions revealed by the diagnosis.

Supplementary Reading

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CHAPTER 17

Social Studies: Motivation and Materials

Extrinsic Motives, Teacher's Marks, and Tests

The social studies, like other subjects, may be motivated partly by extrinsic and partly by intrinsic motives. One of the extrinsic motives is knowledge of progress in learning. This may be derived from teacher's marks, objective tests, or the feeling of increased insight. Among the intrinsic motives are included the results that satisfy an individual's needs or interests. Of the extrinsic motives, an important one arises from the use of tests.

The value of tests, either for motivation or for measurement, depends in part upon their reliability or consistency of measurement. If it is possible for tests to show increases or decreases in scores without corresponding changes in achievement, it is evident that they cannot be effective for the improvement of instruction. It is, then, important to discuss their relative reliabilities.

The reliability of subjective or essay tests is open to question because (1) there is little correspondence between marks based on such tests and scores obtained by objective tests, (2) teachers vary widely in the grades assigned to the same paper, and (3) the scores obtained from one half of an essay test correlate very poorly with the scores obtained from the other half—at least they are far lower than the corresponding correlations obtained from objective tests. The first fact was shown by Eleve

Michell[1] in a comparison of letter grades and objective scores of the same pupils by different teachers. Teacher *A* gave a grade of *A* to 15 percent of her pupils, their median objective score being 71. Teacher *B* gave a grade of *A* to 31 percent of her pupils, their median objective score being 55. Teacher *A* gave a grade of *C* to 48 percent of her pupils, whose median objective score was 59. Teacher *B* gave a grade of *C* to 32 percent of her pupils, whose median objective score was 32. Teachers *A* and *B* were in the same department and taught the same subject, but the pupils to whom teacher *A* gave a grade of *C* made a higher objective score than the pupils to whom teacher *B* gave a grade of *A*.

The variation in teachers' marks on papers written for essay tests in the social studies, has been shown a number of times. For example, Ruch[2] had three such papers regraded by 115 teachers. On paper 1 the marks varied from 70 to 100 with an average of about 88.7, the original mark being 100. On paper 2, the marks varied from 45 to 90, with an average of about 70.3, the original mark being 88. On paper 3, the marks averaged from 25 to 85 with an average of about 56.6, the original mark being 67.

To show the lack of correspondence between the halves of essay tests, Ruch selected 10 sets of final essay papers from 100 or more such tests. Included in these were five sets on history, geography, and civics. Each question was graded separately and the sum of the scores on the odd-numbered questions correlated with the sum of the scores on the even-numbered questions. The average of these correlations was .42, or .57, according to Brown's

[1] Michell, Eleve, *Teaching Values in New-Type History Tests.* Yonkers, N. Y.: World Book Company. 1930.

[2] Ruch, G. M., *Improvement of the Written Examination.* Chicago: Scott, Foresman & Company, 1924.

formula. The corresponding correlations for objective tests ranged from .81 to .90, according to the type of test. For recall 5-response, 3-response, and 2-response tests, it was .90; for the true-false it was .82; and for the 3-response, it was .81. The comparatively low value of the 3-response type was probably an accident. Theoretically, the reliability of a test should increase with the number of possible choices.

The usefulness of a test depends, however, upon other factors than reliability, such as extent of sampling, number of questions which can be given in a certain time unit, the ease and objectivity of scoring, and validity. The extent of sampling of various types of objective tests in the social studies was investigated by Ruch and by Brinkley.[3] Ruch found the number of questions that could be given in 18.7 minutes for different types to be as follows:

Type	*Number*
Recall	100
5-response	117
3-response	139
2-response	164
True-false	183

In a similar investigation, Brinkley found the number of questions that could be given in 31 minutes to be as follows:

Type	*Number*
True-false	100
Multiple choice	57
Completion	44
Word-phrase answer	52
Arrangements	28
Essay	3.5

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[3] Brinkley, Sterling G., *Values of the New-Type Examination in the High Schools.* Contributions to Education, No. 61, New York: Teachers College, Columbia University, 1924.

From the above figures it will be seen that the essay test falls down not only in reliability but also because of the small number of items that can be measured by it. It has value, however, in that it shows the student's ability to organize his thoughts around central topics into good English. For tests which make fair combinations of reliability and extent of sampling, the recall and multiple-choice tests rank high.

Deficiencies and Possible Improvement of Tests

From the standpoint of the teacher, the goodness of a test depends primarily upon its validity; that is, upon the extent to which it measures what the student is supposed to learn from the content of a course. A valid test samples the significant items in the curriculum. One question which we would ask about a test is: Does its content contain significant items? Psychologically there are several phases to the mastery of content, including knowing the facts, understanding them, and forming a proper social attitude from their study. So we would ask an additional question about a test: Do the items measure primarily memory, understanding, attitude, or all three? Again we may subject the content of a test to the same criteria as the content of a curriculum, namely: Is it relevant to the essential objectives of the social studies? A judgment about deficiencies and the possible improvement of existing tests in the field of the social studies may be formulated from a study of them with reference to these questions.

A study which gives us an idea of the content of existing tests was made by Thornton [4] in 1929. He analyzed ten tests in United States history by counting the number

[4] Thornton, Dean E. W., "The Use of Informational Tests in American History Teaching," *Historical Outlook*, Vol. XX (1929), pp. 12–16.

of topics falling in each period of history and also by calculating the percent of content in each test relating to military, social, and political facts. The analysis showed that 9 percent of the topics fell in the period previous to 1607, 74 percent fell in the period from 1607 to 1865, and 17 percent fell in the period from 1865 to the present. But when we compare the 17 percent of the content of tests devoted to the period since 1865 with the fact that 86 percent of the historical references in 27 books on contemporary problems referred to this period, we see that existing tests have little in them that is important from the standpoint of contemporary problems. This, however, is not a fault of tests so much as it is of the curriculum, but it shows that each has the same faults or merits.

A study indicating that existing tests measure memory and intelligence rather than understanding of social facts was made by Krey and Wesley.[5] They made up an informational test on modern European history that met the approval of a number of teachers of the subject. This test was then given to four different groups, namely: a class of 33 college students, a group of 11 select high-school students, and a group of average high-school students, all of whom had completed a course in this subject; and an experimental group of superior high-school students who had not studied the subject but who had spent a week in cramming for the test. The college students made the highest median score, but the five experimental students made a higher median than either of the high-school groups who had had systematic instruction in the subject. Krey and Wesley concluded that an informa-

[5] Krey, A. C., and Wesley, Edgar B., "Does the New-Type of Test Measure Results of Instruction in the Social Studies?" *Historical Outlook*, Vol. XXIII (1932), pp. 7–21.

tional test does not measure the effects of systematic instruction.

Their next step was to make up what they called an idea test, or test of the understanding of social facts and relationships. This test took the form of a multiple-choice or five-response type and was given to four similar groups. In this case the experimental group which had done a week of cramming ranked below the college group and the select high-school group who had had systematic instruction in the subject, but above the average high-school group. The experiment suggests that knowing facts and understanding them are not synonomous and that one means of improving tests is to make tests which measure understanding and thought rather than information—which is the predominating feature of existing tests. This is the controlling idea in the later tests in the field of the social studies. Among them are the tests standardized by Pressey, by Wesley, and by Kelty and Moore.[6]

Besides failing to emphasize thought and understanding, existing tests do not measure attitudes or habits of skill in dealing with problems of citizenship. This problem is on the way toward solution by Thurstone's method. His technique is to indicate a large variety of attitudes toward a situation, for example, the Christian Church or the Japanese people, then have the pupil check the ones which meet his approval. But tests of this kind, as well as those on the existing curriculum, cannot be brought to a high degree of precision until there is more agreement on the content of the social studies, the objectives to be attained, and the attitudes and habits to be formed. As long as the only requirement in the social

[6] Kelley, Truman L., and Krey, A. C., *Tests and Measurements in the Social Sciences*. New York: Charles Scribner's Sons, 1934.

studies is the taking of a certain number of units for graduation, so long will their mastery be scattered and haphazard. But once we have formed clear conceptions of the goals to be attained, then we may expect some uniformity in regard to their mastery. Clear conceptions of goals will also give us the foundation for making diagnostic tests, for diagnosis always refers to a difficulty in reaching a certain end.

Because of these shortcomings in tests, their use for either motivation or measurement is handicapped; but even so, they should have a prominent place in instruction. Their deficiencies can be and are being remedied. They tell us the direction in which we are going, where we are falling short, where we are succeeding, and to a certain extent, give us an idea of the amount of progress toward our goals. Although teachers try to realize still other types of progress which are not as yet measured by tests, these are possibilities for the future.

Requirements of Intrinsic Motives

Although motivation from tests is important, more effective motivation should come from the intrinsic values of the subject or from the satisfaction which the subject itself gives to individual needs. To do this the content must meet certain requirements, namely:

1. It must be of such a character as to make the objectives readily realizable.
2. It must contain exercises and techniques for developing desirable habits, attitudes, and beliefs.
3. It must be of such a quality that it is readily learnable.
4. It must be in such a quantity that a reasonable mastery is possible.

Before examining how well the materials used in the social studies meet these requirements, it will be helpful

to summarize the development of the social studies curriculum.

The Development of the Curriculum for the Social Studies

Serious work on determining the proper materials for the social studies began with the Committee of Ten[7] in 1892. It recommended nothing but various kinds of history from Grade V to Grade XII, although in the latter it recommended a half year of civics. The Committee of Seven in 1898, which confined its work to the high school, made the same recommendations except that it rearranged the courses in history. Since that time the scope of the social studies has been greatly enlarged in the direction of community problems, economics and sociology. The character of history and of civics has also changed greatly. History, instead of being a narrative of work and changes in governments, has been modified to include social and industrial development as well, and these topics have been put in at the expense of military topics. The amount of history has also been greatly reduced. Instead of giving three years of European history, the tendency now is to offer only one year of it under the title of "world history." Civics has changed from a dry analytic study of structure of the federal government to a study of community problems in Grade IX, and to a study of national social problems in Grade XII. American history has suffered the fewest changes of any of the courses recommended by the Committee of Ten in 1892. The committee recommended an elementary course for Grade VII and a secondary course for Grade XI. The first is now the prevailing social study for Grade

[7] Committee of Ten on Secondary School Studies. New York: American Book Company, 1894.

VIII, while the second is the prevailing subject for Grade XI, although for a time it had a similar status in Grade XII. The principal changes in American history have been in its character rather than in its amount.

Although certain courses have come to prevail in certain grades, there are many exceptions. These are so numerous that the curriculum in the social studies has been called a confusion of tongues. For example, Kyte[8] found no uniformity either in grade placement or in courses called by identical names. Of 53 courses of study that he examined, he found 25 placing American history in Grade IV, 41 placing it in Grade V, 18 in Grade VI, 43 in Grade VII, and 42 in Grade VIII. Many topics were repeated and sometimes omitted. For example, the "Period of Discovery and Exploration" was omitted in 2 courses, given once in 18 courses, twice in 22 courses, three times in 7 courses, and four times in 2 courses. In the courses given in any one grade the most uniformity was found in Grade VII, although even here the history offered covered periods ranging in length from 70 years to 2700 years. Some began with 750 B.C. and ended 1763 A.D.; some began with 1000 A.D. and ended around 1800 A.D.; some began with 1453 A.D. and ended in years varying between 1763 A.D. and the present; some began with 1607 A.D. and ended 1763 A.D.; some covered only the period since the civil war.

Similarly the History Inquiry[9] of 1924 found each of the following courses offered in each of Grades IX, X, XI, and XII in various high schools, the only exception being sociology, which was not offered in Grade IX: ancient

[8] Kyte, Geo. C., "Variations in Organization of the Elementary Courses of Study in History," *Educational Administration and Supervision*, Vol. XIII (Dec. 1927), pp. 361–376.

[9] Dawson, Edgar, *The History Inquiry: Report of the Director*. Philadelphia: McKinley Publishing Company, 1924; also *Historical Outlook*, Vol. XV (1924), pp. 239–272.

history, ancient and medieval history, medieval history, modern history, world history, English history, American history, American history and civics, community civics, vocational civics, economic civics, problems of democracy, social problems, sociology, and economics. The impression one gets from this is that the objectives of the social studies must be realized somehow from the study of the materials of social science; the specific order and the specific kind of material are unimportant.

The Relevancy of Social-Studies Courses to General Objectives

The relevancy of social-studies courses to the general objectives of the study may be judged partly by the titles of courses and partly by the specific topics studied and the amount of space devoted to each. The final test of its adequacy, however, will be the accomplishment of the objectives as shown in the changed behavior of individuals. The names of the courses given in the foregoing paragraph indicate that the content is suitable for the objectives stated—but indications do not constitute evidence, which is supplied, rather, by the amount of space devoted to specific topics. A study which sought to supply this information for nonhistorical courses was made by Dahl.[10] His results are given in Table 24.

Table 24 may be studied from two points of view: first, from the point of view of the relevancy of the topics to the objectives of the social studies, and second, from the point of view of the economy of learning. From the first point of view we can see that the material relates to the following objectives: knowledge of the interdependence of nations; knowledge of the function structure, and

[10] Dahl, Edwin J., "The overlapping of content material in senior high-school social science textbooks," *Historical Outlook*, Vol. XIX (1928), pp. 80–87.

TABLE 24

AVERAGE NUMBER OF PAGES DEVOTED TO EACH TOPIC IN SENIOR HIGH SCHOOL TEXTBOOKS IN THE SOCIAL STUDIES

(From Dahl, 1928)

Topic	Average Number of Pages			
	Civics	Problems	Economics	Sociology
Communication and transportation	5.8	10.0	4.4	0
Community	7.6	9.9	0.1	8.9
Exchange	10.2	13.8	67.1	0
Family	2.5	11.3	0	32.6
Foreign relations, including tariff	19.6	18.6	10.8	0.1
Origins and beginnings of state and government	13.3	22.0	1.5	9.0
Historical development of U. S. government and general features	70.1	37.8	16.4	2.6
Government:				
National	65.5	11.0	0	0
State	13.7	4.0	0	0
County	10.7	2.0	0	0
City	11.5	5.3	0	0
The individual, including consumption	12.8	22.2	8.9	18.8
Labor, including wealth	8.5	39.7	75.2	33.0
Population	4.2	20.0	3.2	40.3
Protection:				
Accidents	1.1	2.6	0	4.5
Crime	10.9	17.3	0	16.8
Fire	.6	0	0	0
Handicapped	3.7	11.0	0	25.4
Health	7.3	7.5	0	16.0
Religion and the church	.3	4.4	0	7.6
Production	13.5	38.4	97.3	19.6
School and education	7.9	9.8	0.4	12.8

processes of the national government; knowledge of national problems; knowledge of the relation of the state government to the federal government and local community; information relating to habits of safety, such as prevention of accidents, fire, and disease; and understanding of important social institutions, such as the family, the community, the state, the school, and the church. From the standpoint of economy of learning, the signifi-

cant fact about Table 24 is the overlapping of the content in different courses in the social studies. Textbooks in civics and those in problems of democracy cover the same topics, with the important difference that the textbooks in the problems course devote more pages to a given topic than do those in civics. The only exception is in the case of topics relating to government, on which civics lays particular emphasis. There is not much overlapping between economics and sociology, but each overlaps a good deal with problems of democracy. The overlapping between civics and problems of democracy is avoided by those who do not go through the senior high school, but it raises a serious curricular problem for those who do.

Courses in United States history. An analysis of the content of textbooks in United States history was made by Earle Rugg.[11] He examined four elementary texts and four high-school texts published between 1912 and 1918 and determined the percentage of space devoted to each of ten periods into which the history of the United States was divided. His analysis showed that the content between elementary and high-school texts was practically the same. Rugg declared that the main difference was that "the lower level stresses *economic and social* content more (an average of 42.1 percent as against 38.93 percent for high-school texts) and the latter level stresses *political* content more (an average of 58.3 percent for the senior high-school courses and of 41.45 percent for the upper grade courses)." In addition there is, of course, a difference in difficulty and in depth. The content relates to the objectives "How the nation came to be as it is," and "How the state and community came to be as they are." The practical identity of the two courses raises again the

[11] Rugg, Earle U., *Curriculum Studies in the Social Sciences and Citizenship.* Greeley, Colo.: Colorado State Teachers College, 1928.

important question whether this duplication is justifiable from the standpoint of the economy of learning.

Courses in world history. The content of textbooks in world history for the senior high-school may be seen from an analysis of four texts made by the writer. Of these, two were first published in 1932, one in 1928, and one in 1926. The divisions in the textbooks do not always fit the categories used, and in many cases, the number of pages falling within the category was a matter of judgment.

According to the results, there does not seem to be much agreement upon the relative emphasis to be given the various periods. The beginnings of history before the rise of Greek civilization received only 20 pages from one author and 120 pages from another. Greek civilization received 25 pages from one author and 134 pages from another. The number of pages given to medieval life varied from 70 to 163; the number given to nationalist origins varied from 60 to 302; and the number of pages given to the World War and its results varied from 85 to 112. These variations are rather striking in view of the fact that the respective authors were agreed that the important objective is the understanding of the present-day world. In spite of the variations the content is relevant to the following objectives: Knowledge of the interdependence of nations and knowledge of how the nations came to be as they are. It may also impress the student with the evils of war and the desirability of the judicial settlement of international disputes. Studies of the titles of courses and of the amount of space devoted to specific topics lead to the conclusion that the materials of the social studies are adapted to the accomplishment of most of the informational objectives of the subject. But how well these materials are assimilated and how much they ac-

complish in changing an individual's behavior, beliefs, and attitudes is another question. The extent to which they do this is the real test of their adequacy.

The Relevancy of the Contents in the Social Studies to Specific Objectives and Specific Needs

Investigations have shown that the content of the social studies is inadequate for meeting the specific needs of pupils. One of the first studies to show this inadequacy was made in 1917 by Horn,[12] who investigated the extent to which elementary courses in history prepare a student to deal with the problems of present-day life, and which aspects of history are relevant to present problems. His method of solving this problem was to analyze the historical references found in 27 books on contemporary problems and 142 encyclopedia articles. He found that in the books 85.7 percent of the references were to historical events that occurred after 1861, that only 4.7 percent referred to events between 1812 and 1861, and that the remaining 9.6 percent referred to still earlier events. On the other hand, in elementary texts 24.67 percent of the dates referred to the period between 1861 and 1916, 21 percent to the period between 1812 and 1861, and the remaining 54.33 percent to the earlier periods. A similar study made by Swisher in 1918 on the historical references in books and encyclopedia articles dealing with contemporary political problems showed that 74.12 percent of them referred to the periods 1861–1916 and 16.39 percent to the period 1812–1861. An analysis by Floyd[13]

[12] Horn, Ernest, "Possible Defects in the Present Content of American History as Taught in the Schools," *Sixteenth Yearbook* of the National Society for the Society of Education, 1917, Part I, pp. 156–172.

[13] Floyd, Oliver, "Overlapping between the Senior High School Courses in Problems of Democracy and American history," *Historical Outlook*, Vol. XXII (1932), pp. 296–302.

of 2,501 historical allusions found in four current textbooks to "problems of democracy" showed that 1,408 of them referred to events since 1900, 325 to events between 1865 and 1900, 220 to events between 1820 and 1865, and the remainder to earlier periods. These and similar studies show that histories as now written and taught in the schools are not constructed primarily for the purpose of equipping the student to deal with contemporary problems.

Further evidence of the truth of this conclusion was supplied by a study made by Earle Rugg which inquired specifically into the extent to which the curriculum of the social studies met the needs of students. He investigated five points: (1) provisions made by textbooks for acquainting pupils with the problems of community life, (2) provisions made by textbooks for acquainting pupils with important social concepts, (3) provisions made by textbooks for acquainting pupils with topics of social value, (4) provisions made by textbooks for acquainting pupils with facts of value to the consumer, and (5) whether the dates, persons, places, and other facts related in history were the ones needed for contemporary life.

Provision in textbooks for problems of community life. In answer to the first question he presented an analysis of the number of lines or pages which each of six social-science texts contained on each of eighteen questions relating to the best form of municipal government, city planning, maintenance of public works, maintenance of efficient educational institutions, maintenance of adequate health agencies, and adequate provision for the leisure and recreation of the citizens. All these questions were agreed upon by five or more experts as being important for social well-being in contemporary life.

Rugg found that the average space devoted to these questions varied from .12 of a page to 2.88 pages, the smallest average relating to the question, "Why is a municipal water supply crucial?" and the largest average relating to the question, "What are the main facts concerning the growth of cities?"

Provision in textbooks for important social concepts. In answer to the question of the provision of textbooks for interpreting important social concepts, Rugg presented the number of pages or lines given by each of twelve social-science textbooks on each of the concepts enumerated in Meltzer's study described on page 409. Of these books, three were on community civics, three on advanced civics, two on problems of democracy, two on economics, and two on sociology. No space at all was given to the following concepts: *balance of power, big business, centralized government, conservative, constitutional government, prime minister, radicalism,* and *wage earner*. An average of less than a page was given to each of the following: *Americanism, anarchist, aristocracy, capitalist, industrial country, industrial revolution, large scale production, liberalism, militarism, open shop, patriotism, personal rights,* and *public opinion*. Less than two pages were given to each of the following: *democracy, division of labor, interdependence*. Less than three pages each were given to *foreign trade* and *labor union,* less than four pages each to *conservation of natural resources,* and *socialism,* and less than five pages to *monopoly*. These concepts were selected by Meltzer on the basis of frequency of occurrence in the writings of experts on contemporary social problems. They are keywords to the understanding of modern social problems, but from the amount of space devoted to them in textbooks, it is impossible to understand them.

Provision in textbooks for topics of social value. On the question of the provision of textbooks for topics of social value, Rugg presented the percent of space in economics textbooks in relation to the percent of references to economic topics in periodical literature, as found by Bowman. Out of the ten most frequent topics, there were three, finance, large scale industry, and monetary system, that were treated more fully in textbooks than in periodicals, but the others were treated much less fully. For example, in the periodicals 21.53 percent of the space related to transportation while only 0.83 percent of the space in textbooks related to this topic; 19.60 percent of the space in periodicals related to labor while only 9.88 percent of the space in textbooks related to this topic. Similar results were found for investments, prices, business, food supply, and immigration. On economic facts of importance to the consumer, such as those pertaining to buying a home, amount of rent to pay, standards that should be maintained in housing, and housing regulations, the materials given in five textbooks varied from 0 to 1.5 pages.

Rugg also found that writers on modern problems differed widely with writers of textbooks on the importance of dates and persons. For example, the ten most important dates found by Swisher in the works of writers on modern problems were 1910, 1900, 1908, 1912, 1890, 1907, 1894, 1897, 1909, and 1896. On the other hand, the ten most frequent dates found by Rugg in textbooks were 1860, 1850, 1861, 1812, 1865, 1862, 1890, 1863, 1864, and 1775. As to the frequency of mention of persons in periodicals, Washburne's study showed that the ten highest were Roosevelt, Lincoln, Wilson, Taft, Kipling, Christ, Napoleon I, Bryan, Shakespeare, and Lloyd George, but in the textbooks Rugg found them to be

Washington, Lincoln, Jackson, Jefferson, Grant, Clay, Cleveland, Wilson, Lee, and Roosevelt. In regard to the frequency of mention of locational facts, Washburne's list showed the first ten to be America (U. S.), England, France, New York City, China, London, Germany, Boston, New York State, and Paris, while in the textbooks Rugg found them to be United States, Europe, Asia, England, North America, France, New England, Australia and Africa. In five objective investigations to find the most important topics in the social studies, Rugg found 57 different topics. Of these 24 were mentioned in two or more studies, but only 9 of the 57 were discussed in representative textbooks.

Provision in textbooks for practical citizenship. In regard to the provision in textbooks for training a student to perform the duties of a citizen, Rugg reported two studies, one by Mahan and one by Gass. Mahan interviewed 80 lay citizens on their opinions of the most important duties of a citizen, listed the duties in their order of frequency of mention, and investigated the amount of space in textbooks devoted to these duties. He found that only two percent of the space in textbooks related to these duties. Gass had 18 classes report the civic transactions made by the parents of the pupils during a certain period. He then calculated the percentages of these acts that fell into various classes, and the percentage of space in textbooks devoted to the same classes. He found that the amount of space in textbooks given to international affairs was much too great, while that devoted to municipal, county, and township transactions was much too little, as measured by the distribution of the performances of the citizen.

Outside of the provision in textbooks for the practical duties of a citizen, we may inquire what provision is made

for the needs of a citizen as a consumer of the goods and services of society. What do textbooks tell him about the management of the family income, the purchase of food, housing materials, automobiles, clothing; the handling of investments and savings, the values of insurance, the methods of travel and communication, the maintenance of health, the use of leisure, and the sources and methods of protection against the wiles and arts of the seller? Koos [14] in one investigation analyzed the number of mentions of such topics in sixteen social-study textbooks, eight of which were published between 1925 and 1929 and eight between 1931 and 1934. Those published before 1930 had a total of eleven mentions and those published since 1930 had a total of twenty-seven mentions of the needs of the consumer.

In another investigation, a similar study was made of the treatment of these topics in textbooks on general business, home economics, junior high-school geography, general science, biology, chemistry, and physics. The number of consumer's items recognized in these books varied from 4 in geography and biology texts to 87 in those on home economics. The outstanding fact of each study was the meagerness of the recognition given to the educational needs of the consumer. Such a lack of recognition is justifiable only if we consider the function of education to be that of training the individual how to fool or take advantage of others.

The conclusion to be drawn from these studies is that the content of textbooks in the social studies is far from being adequate for the needs of students, as measured by its service value for reading in periodicals, for dealing with contemporary social problems, for discharging the

[14] Koos, Leonard V., "Consumer Education in the Secondary School," *School Review*, Vol. XLII (1934), pp. 737–750.

duties of a citizen, and for meeting the needs of a citizen as a consumer. If, however, other objectives are set up as more fundamental, such as an appreciation of the past, an understanding of the structure of government, or a knowledge of certain national problems, then the content in textbooks may be more defensible.

The Curriculum from the Standpoint of Habits and Attitudes

The curriculum discussed so far relates to knowledge, but knowledge is only one of the factors needed by a good citizen. His efficiency depends to an equal degree on correct attitudes and habits. Knowledge is but a halfway measure in the attainment of those goals upon which effective action really depends, but this halfway step is the most that textbooks and other sources of information supply. Apparently the greatest defect in the social-studies curriculum is its failure to provide adequately for the formation of habits and attitudes of citizenship. According to an investigation by Moore,[15] at least two thirds of high-school juniors and seniors have strong ambitions to contribute to social welfare. Only 4 percent of them recognize the school as a source of such ambitions; they have no understanding of the social problems which they wish to solve and have no conception of the need of coöperating with others in doing so. Longstreet[16] found that a course in American history had no effect on the attitudes of pupils insofar as they are measured by the Thurstone Attitudes Scales, and according to a study of

[15] Moore, H. H., "Autobiographical Sketches of High-School Students Revealing Their Social Impulses," *Social Studies*, Vol. XXVI (1935), pp. 433–443. Also "The Cultivation of Social Interests Among Older High-School Pupils," *Social Studies*, Vol. XXVII (1936), pp. 28–36.

[16] Longstreet, Rupert J., "An Experiment with the Thurstone Attitudes Scales," *School Review*, Vol. XLIII (1935), pp. 202–208.

Strathers,[17] pupils may and do earn high citizenship marks regardless of their scholastic achievement. However, an opportunity for the formation of habits of citizenship is supplied by student nonathletic activity organizations. According to a study made by Reavis and Van Dyke,[18] high school graduates who participate in these activities believe that they develop such traits as sense of duty, coöperativeness, public spiritedness, initiative, self-confidence, self-reliance, democratic attitude, self-control, and willingness to abide by majority decisions. Some of the reasons given for participating in these activities are also in line with the objectives of the social studies; these include easing the problem of discipline, providing opportunity for leadership, and making school life less irksome. It is also in favor of activities that they give the student an opportunity to participate in those in which he is interested, to develop his creative powers, and to learn through expression rather than reception. On the other hand, there are some activities which are not closely related to the social-study objectives. Over 80 percent of them are departmental, journalistic, dramatic and literary, musical, and special-interest clubs. As such, they have their own objectives just as each subject of the curriculum does. Only about 18 percent of the clubs are classified as relating to student government, school service, social and moral development, and leadership. Besides, the aims and purposes of these activities seem to be even less well defined than are those of the subjects in the regular curriculum. Reavis and Van Dyke found that

[17] Strathers, H. M., *An Analysis of the Distribution of Scholastic Marks and Citizenship Marks at Rocky River Junior High School and the Relation of Citizenship to Scholastic Achievement.* Master's thesis, Ohio State University, 1934.

[18] Reavis, W. C., and Van Dyke, G. E., *Nonathletic Extracurriculum Activities,* Bulletin No. 17, 1932, National Survey of Secondary Education, Monograph No. 26, Washington, D. C., 1933.

many sponsors and administrative officers of schools did not have clear ideas of the purposes and aims of the program of activities. Under these conditions we cannot be too hopeful that the nonathletic-activity organizations will accomplish those objectives of the social studies in which the regular studies fall short.

The Learnability of the Materials in the Social Studies

The question of the learnability of the material used in the social studies can be answered in part by comprehension tests on the material, and in part by an analysis of the vocabulary difficulties in the material. Studies with comprehension tests were made by Ayer,[19] and by Matthews,[20] while vocabulary analyses were made by Rugg,[21] Kepner,[22] Hatch,[23] Shambaugh,[24] Baumgartner,[25] and a number of others.

Studies with comprehension tests. Studies with comprehension tests indicate that the comprehensibility of social-studies material may be greatly increased and that high-school pupils are very imperfect in their comprehension. These facts are illustrated in the studies by Ayer and by Matthews. Ayer selected passages from 23 widely used textbooks on American history written for Grade V.

[19] Ayer, Adelaide M., "Some Difficulties in Elementary School History," *Contributions to Education*, No. 212. New York: Teachers College, Columbia University, 1926.

[20] Matthews, C. O., "The Grade Placement of Curriculum Materials in Social Studies," *Contributions to Education*, No. 241. New York: Teachers College, Columbia University, 1926.

[21] *Op. cit.*

[22] Kepner, Tyler, "Vocabulary versus Content in Junior High School Social Studies," *Historical Outlook*, Vol. XX (1929), pp. 30–34.

[23] Hatch, H. Thurston, *A Study of Word Frequency in American History Textbooks*. Master's thesis, University of California, 1930.

[24] Shambaugh, C. G., "A Study of the Vocabulary of Ancient History Texts," *School and Society*, Vol. XXVIII (1928), pp. 494–496.

[25] Baumgartner, E. H., *Some Vocabulary Difficulties of Eleventh and Twelfth Grade American History*. Master's thesis, University of Illinois, 1935.

These were paralleled by simplified forms of the same paragraphs which eliminated difficulties such as abstract words, literary embellishments, abstract thoughts, technical words, and involved sentences. The comprehension of each form was tested by having the pupil check true-and-false statements following the paragraphs. The modified forms yielded much higher scores than the originals; for example, 5.54 as against 3.83, and 14.91 as against 2.27.

Ayer also investigated the degree of comprehension of the original paragraphs in relation to the reading ability of the pupil, as measured by the Thorndike-McCall Reading Scale. She found that the percent of correct answers to questions on the original paragraphs increased from 25 for pupils having a grade score in reading of 6.5, to 93 for children having a grade score in reading of 10.7. The fact that a sixth grader can comprehend only one fourth of the content of a fifth-grade text indicates that this material is too difficult for the grade for which it is intended. This was also indicated by tests in which Ayer had pupils write free interpretations of paragraphs read. For example, one paragraph which told about Franklin's sojourn in France and how he was revered as one of the greatest Americans was interpreted to mean that "if Franklin didn't go to France, he would have lost the world war."

Matthews made up tests on the materials in Harold Rugg's "Social Science Pamphlets" which were prepared for Grades VII, VIII, and IX. He gave these tests to about 10,000 pupils from Grades IV to XII who had not studied these books. He found that comprehension for the materials increased considerably from Grade IV to Grade XII, but that in every grade the mastery was imperfect. For reading materials the median percent of questions answered correctly increased from 25.2 in Grade

IV to 84.5 in Grade XII. For maps the corresponding increase was from 11.3 to 73.8; for graphs it was from 10 to 65; for pictograms it was from 16.3 to 73.8; for time lines it was from 13.8 to 67.3.

Vocabulary studies. Vocabulary studies indicate that too many words used in the social-study material are unknown by the pupils. For example, Earle Rugg measured vocabulary difficulties by selecting four full pages from four representative textbooks in the social studies. He then gave each word its credit ranking according to Thorndike's *Teacher's Word Book.* He found that slightly over 95 percent of the words in two books intended for the junior high school were within the first 4,000 words in Thorndike's text, and that less than 2 percent were over the first 10,000. The two books intended for Grade XII had about 90 percent of the words in the first 4,000 and less than 4 percent over the 10,000. One's first impression from these results is that the word difficulties are few, but when we consider that 3 percent of the words on each page are not in the Thorndike list and that probably over half of these occur but once in the book, it becomes clear that we shall have a heavy vocabulary burden by the time we cover 600 pages.

Kepner collected 700 words which gave difficulty to approximately one half of 1,200 pupils in Grades VII, VIII, and IX. He found that 53 percent of these words were common or nontechnical or not peculiar to the social studies. Of the common words 21 percent were in the Thorndike list of 10,000 words, and of the technical words 28 percent were in this list. Kepner's conclusion was that instruction in the social studies is handicapped by vocabulary difficulties and that over half of these difficulties were unnecessary.

Shambaugh made a word count of six popular text-

books covering the period of ancient history and found that all but about 3.5 percent of the words occurred in the Thorndike list. But when he considered the total number of different words used, he found that from 17.2 to 39.2 percent of them did not occur in the first ten thousand of the Thorndike list, that over half of these occurred but once in a book, and that consequently the pupil had little chance to become familiar with them.

Hatch counted the words in eight American history texts for the senior high school. He concluded that over 1,000 of the words used would cause difficulty to the average high-school student and that the texts were too difficult for the students for whom they were written. Baumgartner, in a similar study, found that on the average, textbooks in American history used 21.1 technical phrases for every 100 lines of text, and that juniors and seniors were familiar with only about half of the terms.

The writer gave a difficulty grade according to Thorndike's *Teacher's Word Book* to each word on each of four pages in four recent books on world history. He selected the nearest full page to pages 150, 300, 450, and 600 in each book, then calculated the percent of words occurring in the first 5,000 of the Thorndike list, the percent in the second 5,000, and the percent not in the Thorndike list. The results were that about 91 percent of the words, as measured by this method, were in the first 5,000 of the Thorndike list; about 4.5 percent were in the second 5,000, and about 4.5 were not in the Thorndike list. Some of the words not in the Thorndike list found on the four pages counted in one of the books were *output, humorists, versus, monopoly, curriculum, drastically, sinecures, clique, financier, itemized, energetically, redivided, inequalities, inquisition, vaccination, inefficient,*

brigands, mismanaged, favoritism, homogenous, racial and *staunch.*

An idea of the difficulty of these words may be obtained from the number of them missed by one superior ninth-grade child, one superior tenth-grade child, and one college freshman who stood in the upper 20 percent in knowledge of words. The ninth-grade child did not know 13 of the 22 words given above; the tenth-grade child did not know 10 of them, and the college freshman did not know 4 of them. According to these results, if 6 percent of the running words are not in the Thorndike list, the average tenth-grade child would have to look up nine or ten words for each page of text, or about a hundred words for an assignment of ten or twelve pages. It is evident that this is far too many and that it would make careful study or reading a very slow and tedious process. If the percent of words not in the Thorndike list is reduced to 3, the number of new words to be looked up in an assignment of ten or twelve pages would be reduced to 50. Even this is a large number, probably larger than any high-school pupil would take the trouble to look up in the dictionary.

The conclusion to be derived from these studies is that the materials offered in the social studies contain many unnecessary difficulties and that it is possible to make them much more comprehensible than they are now. But there is a limit beyond which the simplification of the materials should not go. Probably no one would hold that the vocabulary of the reading materials used in the secondary schools should be restricted to the first 5,000 words in Thorndike's list or to the vocabulary of the average sixth-grade pupil. On the other hand, the pupil's vocabulary should grow with his educational progress. If this is true, a few new words on each page of text in the

social studies is justifiable. How many there should be is a matter of dispute, but it would seem that if 97 percent of the running words used in the social studies in junior high school, and 95 percent of those in senior high school are in the Thorndike list, there would be little ground for complaining of vocabulary difficulties. This might leave from five to ten words on a page that are not in the Thorndike list, but at least half of these would be known to the average pupil, and if the other half are new, the dictionary is available for the enrichment of his vocabulary.

The Quantity of Material to Be Learned in the Social Studies

Since only a fraction of the time available for secondary education is allotted to the social studies, it is evident that the quantity of material to be learned must be carefully adjusted to the available time and capacities of the pupils. Accurate information about the solution of this problem is not available at present. We know that the average high-school pupil can remember only seven or eight numbers after one hearing but how many he learns in 100 minutes a day, five days a week, we do not know. Likewise we do not know how many social facts he can learn in that amount of time. On the other hand, there is no accurate way of determining the number of facts to be learned. Even if we have available the books or other materials that are to be studied, it is difficult to tell how many facts are in them. Is there an important fact in every sentence, in every paragraph, in every chapter, or is the entire book intended to convey only one important fact? A defense could be made for determining the number of facts by each of these units of thought, but for practical purposes, the writer believes that a fair idea of the number of facts in a book can be obtained by count-

ing the paragraphs. If an author devotes a paragraph to a point, he usually considers it to be of sufficient importance to be set apart from others and possibly worth learning, although a paragraph may be only a step in an argument or a preparation of the way for what the writer is going to say next. The present paragraph is an example of such a case.

In an effort to get an idea of the number of facts to be learned in the social studies in the secondary schools, the writer has counted the number of paragraphs in ten textbooks in the social studies. Four of these were United States histories for the junior high school; four were world histories for the senior high school; one was a book on community civics for the junior high school, and one was a book on problems of democracy for the senior high school. The number of paragraphs and the number of pages in each book are given in Table 25.

TABLE 25

Number of Paragraphs and Number of Pages in Each of Ten Textbooks Used in the Social Studies

Text	Number of Paragraphs	Number of Pages
United States History:		
A	1341	626
B	1743	780
C	1131	697
D	1509	523
World History:		
A	1658	733
B	1725	920
C	2438	873
D	2134	854
Civics:		
A	1443	713
Problems:		
A	1835	616

It will be seen that the number of paragraphs is very large. If each one stands for an important fact or idea, the number is far too great to be mastered in the course of a single year of school. There is ample justification for the most frequently mentioned difficulty in the study of social science, namely: "too many topics." This is true for even the smallest book represented in Table 25, Text *D*, United States history. If it is true for this book, it is still more apparent for the texts in world history. The latter are outstanding in excessive number both of pages and paragraphs. The probable explanation is that they attempt to combine three books, one on ancient history, one on medieval history, and one on modern history, in one volume. The combination so far seems unsuccessful, as the authors of these books have not yet been able to come to an agreement as to what facts from the older books or courses should be included. The number of paragraphs, however, represents more topics than any teacher or author expects a student to master during a year's course. Consequently, there should be clear indications, apart from those contained in the context, as to which ones merit especial attention. But such helps are conspicuous by their absence from practically all the textbooks in the social studies, and constitute a serious deficiency. As long as the latter remains, we can find no remedy for the difficulty of too many topics. The solution will probably take the form of organization of the material around a comparatively small number of central concepts.

By What Criteria Shall Suitable Materials Be Selected?

Fortunately, our discussions up to this point make possible a brief answer to the question of the criteria to be

used in choosing materials: They must meet the requirements of learning and of the objectives. From the standpoint of learning they must be comprehensible to the learner for whom they are intended, and they must be limited enough in quantity to make a reasonable mastery possible within the time available. We have already discussed how comprehension tests and vocabulary tests are used in this connection. From the standpoint of objectives, they must teach how our present institutions have developed; there must be a discussion of their structure and function broad enough to enable citizens to use them intelligently; there must be enough practice material to form habits of skill in discharging the duties of citizenship; and the materials must be so selected that the student acquires the background and the skill for attacking the problems of his own generation in an intelligent manner. The learnability of materials can be passed on by teachers and by psychologists, but their selection with reference to the various objectives should be made by specialists in subject matter and in behavior. The final criterion should be the extent to which learning materials change the student's behavior in the direction desired.

Summary

Motivation by the social studies consists of both extrinsic and intrinsic motives. The extrinsic have to do with knowledge of progress in learning and the intrinsic with the satisfactions of individual needs supplied by the social studies.

The most important of the extrinsic sources of motivation is knowledge derived from tests of achievement, although the usefulness of tests for this purpose depends partly upon their reliability.

Tests vary widely in reliability. The least reliable are essay tests, a fact which is indicated by the low correlations between these tests, wide variations in teachers' marks, and narrow ranges of sampling. Objective tests are much more reliable but these vary in reliability according to type, the most reliable being the recall and multiple-choice type and the least reliable the true-false type.

However, standardized tests in the social studies contain deficiencies: they overemphasize information and neglect to measure understanding, attitudes, and habits. In addition, the information required is too far removed from the world of today. But these defects can be remedied.

The results of reliable tests help motivation by showing the learner's approach to his goal, revealing his deficiencies, and stimulating rivalry.

Intrinsic motivation in the social studies is dependent upon the degree to which the content meets the following requirements: it must have such a character as to make the objectives realizable; it must contain exercises and techniques for developing desirable habits, attitudes, and beliefs; it must be readily learnable; and it must be in such a quantity as to make a reasonable mastery possible.

The present courses in the social studies are a product of historical development.

Serious work in the curriculum for the social studies began with the Committee of Ten in 1892. The latter recommended only history from Grade V to XII, inclusive, with the exception of a half year of civics in Grade VII and another half year in Grade XII. Since the time of their recommendations there have been changes both in grade placement and in content. The content has been enlarged to include economics, sociology, and govern-

ment. The attitude toward history has become less military and more social, and the emphasis, instead of being placed about equally upon all periods, is now centered upon the modern world. The most frequent courses now are geography in Grade VII, United States history in Grade VIII, community civics in Grade IX, world history in Grade X, United States history in Grade XI, and economics and government, or problems of democracy, in Grade XII. There are numerous exceptions, however, and any course may be found in almost every grade. There is also much overlapping of courses, a fact which presents important problems from the standpoint of the economy of learning.

Some idea of the suitability of the courses may be obtained from an examination of the titles of courses offered in the schools, although these convey nothing except that the objective of the social studies must be realized somehow by the study of some kind of courses in the social studies.

The suitability of courses may also be judged by comparing analyses of the content of courses with objectives. These analyses indicate an adaptability of the material to the general objectives, but fail to show how well they are adapted to specific objectives.

Probably the best test to apply to the suitability of materials in the social studies is: does the content meet the specific needs of students for life situations? From this standpoint there is little correspondence between the facts offered in the social studies and the facts regarded as important by writers on contemporary issues. There is far too little material in the textbooks relating to important social concepts and to the discharge of practical duties of citizenship, although there appears to be enough on international affairs.

The greatest defect in the curriculum for the social studies is its failure to provide for the development of attitudes and habits of skill for discharging the duties of citizenship. Extracurricular activities, especially those concerned with student government, may eventually develop into an instrument adequate for this purpose.

The learnability of the materials in the social studies may be measured by comprehension tests and by rating the words used by vocabulary lists of known difficulty. These show that the comprehensibility of the materials can be greatly increased by using simple words, that many books are too difficult for the grades for which they are intended, and that many of these difficulties are unnecessary.

If the number of paragraphs contained in a textbook is a fair index of the quantity of facts to be learned, then the quantity of facts in the social studies is beyond the possibility of complete mastery. Courses in world history are most in need of reconstruction from this standpoint. The remedy is probably not fewer facts but better organization around a much smaller number of central concepts.

The final criterion of the suitability of learning materials should be the extent to which they are effective for changing the individual's behavior in the direction desired.

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CHAPTER 18

Mathematics: Objectives and Organization

Objectives

According to the National Committee on Mathematical Requirements,[1] "the primary purposes of the teaching of mathematics should be to develop those powers of understanding and of analyzing relations of quantity and of space which are necessary to an insight into and control over our environment and to an appreciation of the progress of civilization in its various aspects, and to develop those habits of thought and of action which will make those powers effective in the life of the individual."

This statement mentions two great values of mathematics: control over environment, and appreciation of the progress of civilization. The former may be called a practical and the latter a cultural value. That mathematics has practical value becomes evident when we consider its many uses in buying and selling; in bookkeeping; in managing the accounts of the home, such as bills, rents, interest, taxes, and insurance; in understanding the problems of taxation, public budgets, and public expenditures; in making an effective program for saving and insurance; in understanding certain health problems such as fever charts, blood counts, and death rates for certain diseases; in reading graphs of business cycles; in comprehending rises and falls in price, volume of production,

[1] National Committee on Mathematical Requirements, *The Reorganization of Mathematics in Secondary Education.* The Mathematical Association of America, Inc., 1923.

and other statistical facts; and in using formulas. The latter are invaluable, not only for solving problems in science such as finding the acceleration of a falling body from the time and distance of its fall, but also for solving practical problems such as finding the length of time required in the oven for roasting meat, given the number of pounds. Except for the practical values of arithmetic and the formula, the value of mathematics taught in the secondary schools is cultural for most students; but even so, the cost of teaching it is a justifiable public expenditure.

Mathematics supplies one key for understanding many technical problems and many of the characteristics of modern civilization. Interesting technical problems depending upon mathematics for an understanding include: how the astronomer calculates the distance of stars, how the navigator calculates his position at sea, how the aviator determines his elevation, how the surveyor measures the width of a river without crossing it and the height of a mountain without climbing it. Among the characteristics of modern civilization depending either directly or indirectly upon mathematics are science, engineering, skyscrapers, bridges, railroads, telephones, telegraphs, radios, airplanes, banks, business corporations, large scale production, and all machinery motivated by mechanical power. Although a knowledge of higher mathematics may not be necessary for using these things, it is necessary for producing them and for understanding them. Since this knowledge is necessary for the maintenance and development of our present civilization, it is the duty of the state, through its schools, to find these young people who have mathematical aptitude, and to train enough of them in such higher mathematics as may

be necessary for carrying on and developing the mathematical requirements of our civilization.

Values for Forms of Thought and a Leisure Occupation

In addition to furnishing an insight into technical products and providing many people with vocations, the study of mathematics is valuable in developing useful forms of thought and supplying other people with leisure occupations. One form of thought developed by mathematics, along with all science, literature and philosophy, is abstract thinking. All thought expressed in language is, of course, abstract; but the language of mathematics —of algebra in particular—is possibly more abstract than that of other secondary-school subjects. However, it usually has the advantage of standing for definite relationships.

Mathematics is particularly well adapted for giving training in deductive thinking, or the science of necessary conclusions, although it also provides opportunities for an immense amount of inductive thinking. Writers on mathematics allege in particular that the study of mathematics develops the concept of functional dependence better than the study of any other subject. This claim is debatable, for relations of dependence of one thing on another are found in every science and, in fact, constitute one of the important objectives of every science. But there is no doubt that mathematics is a good subject for the development of this important concept. As a leisure occupation, mathematics is attractive to those who enjoy intellectual play in the form of solving problems, contemplating distances, forms, and ideals of perfection in logic and in truth.

Application of Principles of Learning to Mathematics

Each of our major principles of learning has an important application to mathematics. Organization refers to those factors which make mathematical terms meaningful and by virtue of which they are tied into an understandable system. In teaching mathematics according to this principle, attention is directed to the development of meaning or to the analysis and perception of relations which form the basis of meaning. The principle of practice as applied to mathematics refers to the factors by which mathematical operations are made smooth, quick, and accurate. The principle of individual differences refers to the fact that we cannot teach mathematics according to uniform rules, but rather that each principle must be applied according to the needs, interest, and ability of the individual. The principle of motivation as applied to mathematics refers to those factors by means of which the learning of numbers and of quantitative relations is made interesting, zestful, and vigorous. It is the purpose of this and of the next three chapters to discuss the methods by which each of these principles is applied to the learning of mathematics. In the remainder of this chapter we shall discuss the methods of applying the principle of organization.

Presenting Mathematics Concretely

One of the first conditions of making mathematics meaningful is to make apparent the relationship of numbers and symbols to real objects. In arithmetic this relationship is made meaningful by training the children to count real objects rather than merely repeat words. The first step is to train a child to recognize groups of

objects as containing a certain number of members. The next step is to see that numbers refer to the quantity of objects regardless of the kind; that is, that they refer to only one characteristic of objects rather than to their totality. After the child has passed through these steps, abstract numbers begin to have a meaning for him. Perceptual experience is equally important in enabling the child to understand the meaning of arithmetical processes, for example, the fundamental operations. These, too, must be related to concrete objects in order to acquire meaning. Addition may be made meaningful by teaching it as a process of bringing objects together into a heap, subtraction as a process of taking objects away from a heap, multiplication as a process of collecting a number of groups of the same size, and division as a process of sorting a heap of objects into a given number of bundles of the same size. Fractions may be made meaningful in a similar manner, the principal difference being that instead of dealing with a heap, we take a unitary object, cut it in parts, then conduct our operations with these parts.

Algebraic processes may be made meaningful in a similar manner. We should think of the fundamental operations in the same way: addition means bringing together; subtraction means taking away; multiplication means collecting a certain number of groups of the same size; and division means sorting a heap into a given number of groups of the same size. There are, however, some differences. One of these relates to literal notation and another to signed numbers or quantities having opposite values. The use of exercises in substitution is probably as good a way as any to make the literal notation meaningful, but the realistic demonstration of signed numbers is more difficult. Because quantities may have opposite values, it is possible for addition to

reduce a quantity in size as well as to increase it. Similarly, it is possible for subtraction to increase a quantity in size instead of reducing it. It requires some effort to think of these processes as each having possibilities of increasing and of decreasing. However, it is possible to explain these ideas by a comparison with the relationship between assets and debts. Adding assets to assets increases the amount of the assets, but adding debts to assets decreases the amount of the assets. Subtracting assets from assets reduces the assets, but subtracting debts from assets increases them. In this instance, it is helpful to think of subtraction as a process of cancellation. Adding debts to debts increases the amount of the debts, but subtracting debts from debts reduces the amount. Other illustrations for these meanings may be found in the conception of degrees above and degrees below zero and also in the conception of positive and negative directions from a certain point. But these do not appear as meaningful as operations with debts and assets.

Sometimes meaning can be given to algebraic processes by illustrating them arithmetically. For example, in adding algebraic terms, it is difficult to understand why it is sufficient to add only the coefficients, without making changes in the terms. For example, in adding 6 *ab* and 5 *ab*, or 2 *ab* and 3 *ab*, we say the sums are 11 *ab* and 5 *ab*, respectively. If *a* equals 2 and *b* equals 3 and *c* equals 5, we may illustrate this as follows:

$$\begin{array}{r} 6 \times 2\cdot 3 = 36 \\ 5 \times 2\cdot 3 = 30 \\ \hline 11 \times 2\cdot 3 = 66 \end{array} \qquad\qquad \begin{array}{r} 2 \times 3\cdot 5 = 30 \\ 3 \times 3\cdot 5 = 45 \\ \hline 5 \times 3\cdot 5 = 75 \end{array}$$

This shows why we keep the terms constant but add the coefficients.

Such frequent errors in plane geometry as the failure to identify the kind of polygons, the kind of angles, the parts of an angle, the parts of a circle, the included sides, and the included angle, may be avoided by exercises in concrete geometry, which give a clear visualization of these figures. Such errors are due to lack of first-hand experience with the objects and quantities which are the subject matter of mathematics.

An appropriate method for remedying this condition is to supply the pupil with plain paper, straightedge, compass, protractor, scissors, pencil, and a few wooden triangles, and teach by the laboratory method. The pupil may then draw a triangle with two equal angles, measure the sides opposite the equal angles, and find out that they are equal. He may then draw a triangle with each angle equal to 60°, measure the sides, and discover that they are all equal. Next he may draw a right triangle with one acute angle equal to 60° and the other equal to 30°, measure the sides, and discover that the hypotenuse is just twice as long as the side opposite the 30° angle.

In another class the pupil may be learning how to multiply $a + 5$ by $a + 2$. He does this by drawing a rectangle whose length is $a + 5$ and whose width is $a + 2$. He divides this into four parts. The area of one part is a^2, of a second part $5a$, of a third part $2a$, and of a fourth part it is 2×5, or 10. The total area is thus $a^2 + 7a + 10$. Next, 5 may be represented by b and 2 by c; then the area A of a rectangle whose length is $a + b$ and width $a + c$ becomes $a^2 + ab + ac + bc$, or $a(a + b + c) + bc$, or $a(a + b) + c(a + b)$, or $(a + b)\ (a + c)$. Now, if $a + b = l$ and $a + c = w$ then $A = lw$. Each of these combinations of letters may be easily related to a real and concrete quantity. A series of such exercises should not only overcome the purely symbolic appearance of mathe-

matics, but also increase the ease of forming generalizations. C. A. Stone,[2] who used the procedure outlined here claimed that it eliminated failures, increased the pupil's retention of mathematical facts, enabled the pupil to relate principles and facts, gave him an understanding of the usefulness of mathematics, and made him an independent worker and thinker. Its success was doubtless due to the fact that, in this method, mathematical terms were made clear and concrete.

Developing Definitions Inductively Rather than Deductively

The foregoing illustrations show how mathematical concepts may be developed inductively from experience. Deductive approaches have the advantage of being much briefer, but they are open to the objection that they are unmeaningful. We may start teaching multiplication as the process of taking one number as many times as there are units in another, and then follow with illustrations, but this is a purely verbal process without meaning. If it has no meaning, the child cannot use it. The inductive procedure avoids this objection. It gives the student a better comprehension of the terms, an increased power to deal with new situations, and favors retention. How brief the deductive approach is may be shown from a few quotations from a textbook on geometry:

> A plane figure bounded by four straight lines is called a *quadrilateral*.
>
> If the opposite sides of a quadrilateral are parallel, the figure is called a *parallelogram*.
>
> A parallelogram all of whose angles are right angles is called a *rectangle*.
>
> A quadrilateral all of whose sides are equal is called a *rhombus*.
>
> A rectangle all of whose sides are equal is called a *square*.

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[2] Stone, Charles A., "A Laboratory Method of Teaching Mathematics in the Classroom," *Mathematics Teacher*, Vol. XVII (1924), pp. 208–222.

The text in question has one illustration for each figure. Similarly the following introduction to quadratics has the advantage of brevity:

Quadratic equation. An equation which contains the unknown letter to the second (but no higher) power is called a quadratic equation, or briefly, a *quadratic.*

Thus the equations $2x^2 - 4x = 1$, and $\frac{1}{2}x^2 + x = -3$ are quadratics, but $2x - 3 = 0$, and $4x^3 - 5x^2 + x = 2$ are not.

Pure quadratic. When the quadratic contains the second power only of the unknown letter, it is called a *pure quadratic.*

Thus $2x^2 - 27 = 0$, and $ax^2 = bc$ are pure quadratic, but $x^2 - 4x = 2$, and $x^2 + bx + c = 0$ are not.

Affected quadratic. When the quadratic contains both the first and second powers of the unknown letter, it is called an *affected quadratic.*

Thus $x^2 + 3x = 7$, and $x^2 + 2ax = a^2$ are affected quadratics, but $2x^2 - 7 = 0$, and $5x^2 - 16a^2b^2 = c^2$ are not.

While the deductive procedure here illustrated has the advantage of brevity, it also has the objection of tying up a general term with a particular figure or example, thus handicapping the pupil in the formation of those general and abstract notions which mathematicians boast of as one of the great values of their subject. While it takes considerable space to give a dozen illustrations of a general term, yet the increased ability which it gives for generalizing is well worth the cost. Pedagogically it would be worth while to develop the general terms inductively.

The comparative value of teaching mathematical terms inductively and deductively was tested experimentally by Kastiner[8] with pupils from Grades VI and VII. Equivalent classes were selected on the basis of a mathematical test. In the inductive method numerous figures were put on the board, after which the pupils were asked to study them and to define them as the teacher pointed

[8] Kastiner, Abraham, *An Experimental Investigation of the Inductive versus the Deductive Method of Teaching.* Master's thesis, New York University, 1928.

to them. In the deductive method the definition and an illustrative drawing were put on the board. The pupils were asked to learn them by repeating or writing them. Tests given at the end of the experimental period showed that those taught by the inductive method were better fitted in comprehension, retention, and ability to attack new problems.

Using the Unit Plan

The unit plan adds meaning to mathematics and enables the student to see the logical organization in the subject. A number of investigations have been made of the value of the unit plan in mathematics in comparison with the conventional group instruction by daily assignments. Not all of these investigations agree in their results, but the majority of them are in favor of the unit method. In this group come the studies of Williams,[4] Stollard,[5] Gadske,[6] and Linn.[7] Hunzicker,[8] however, found small differences in favor of daily recitations.

Williams studied the advantages of a modified Winnetka contract plan in algebra, and in seven out of eight comparisons found differences in its favor.

Stollard compared a large-unit plan of supervised study in algebra with a plan of a divided daily period of reci-

[4] Williams, G. B., *A Controlled Experiment to Determine the Efficiency of the Contract Method of Teaching Second Year Algebra to Normal and Superior Pupils*. Master's thesis, Pennsylvania State College, 1932.

[5] Stollard, B. J., *Supervised Study in Ninth Grade Algebra*. Master's thesis, University of Minnesota, 1932.

[6] Gadske, Richard E., "A Comparison of Two Methods of Teaching First-Year High School Algebra," *School Science and Mathematics*, Vol. XXXIII (1933), pp. 635–641.

[7] Linn, Marguerite, "An Experimental Comparison of Two Methods of Teaching Elementary Algebra," *School Science and Mathematics*, Vol. XXXIV (1934).

[8] Hunzicker, C. W., *A Comparison of the Relative Effectiveness of a Plan of Supervised Study and the Daily Recitation Method in the Teaching of Algebra and Geometry*. Master's thesis, University of Minnesota, 1933.

tation and study. His results favored the large unit for the superior students and the small unit for the average students.

Linn compared a large-unit method in algebra with a plan of daily assignments and recitation. During the first semester the results favored the large-unit method, and during the second semester, the plan of daily recitation. In neither case were the differences statistically significant.

The more detailed character of these experiments is well illustrated in the one made by Gadske, who divided 46 pupils into two equal classes on the basis of their scores in tests of intelligence, arithmetic, and reading. The experimental group was taught by unit assignments, the instruction and progress within each unit being strictly individual. Each pupil at the beginning of the course was supplied with a copy of the unit assignments for the entire course. Each unit covered the following items: (1) a statement of the purpose of the unit; (2) a preview of the unit containing samples of the knowledge and skills to be acquired in the unit; (3) a clear statement of the exact work to be done, the order in which it was to be done, and the time the instructional tests were to be taken; (4) a clear statement for a thorough review of the unit, which was to be followed by a mastery unit. In the study of a unit, each pupil progressed according to his ability. He did the assigned tasks, consulted the teacher about difficulties, took the instructional tasks, and performed additional remedial tasks whenever necessary. The class was brought together only twice for each unit: first, for an introduction and preview of the unit; second, for taking the mastery test. The control group received the usual class instruction—lectures, demonstrations, recitations, daily assignments, tests, and group

remedial instruction. There was also some individual instruction, since the last 20 minutes of each 60-minute class period were devoted to supervised study.

The progress of the classes was measured by two tests: Test 1, which covered a little more than the first semester's work; and Test 2, which covered a little more than the usual first year of algebra. In Test 1 there was a difference of 11.4 points, and in Test 2, a difference of 6.4 points in favor of the unit method. In each case the difference was larger than necessary to establish the superiority of the unit over the conventional method.

Rationalizing the Processes

Many errors in mathematics could be avoided if the processes were fully rationalized. For example, the frequent error of forgetting the changed number in borrowing in the process of subtraction might be avoided if the pupil had this process rationalized. In subtracting 37 from 63 it should be easier to remember that six has been changed into five after the following illustration is given:

$$\begin{array}{rcrr} 63 & = & 50 \text{ plus} & 13 \\ 37 & = & 30 \text{ plus} & 7 \\ \hline 26 & = & 20 \text{ plus} & 6 \end{array}$$

Many errors in both algebra and geometry seem to be due to lack of comprehension or rationalization.

Thorndike,[9] for example, found that only 3 percent of a group of college students failed to find the factors of $x^2 - y^2$, but that 39 percent failed when the problem was to find the factors of $1/x^2 - 1/y^2$; also that 58 percent failed to multiply x^a by x^b, but 71 percent failed to multiply 4^a by 4^b. He said that this increase in error was due

[9] Thorndike, E. F., *Psychology of Algebra.* New York: The Macmillan Company, 1923.

to interference caused by a change from the customary form. This analysis is probably correct, for, by habit, $4^a \times 4^b$ gives 16^{a+b}, and $x^a \times x^b$ gives x^{a+b}, but if the pupil should stop to rationalize, he could reason that if $x^a \times x^b = x^{a+b}$, then $4^a \times 4^b = 4^{a+b}$. Habitual processes are easily disturbed by a change in the customary stimulus, but this disturbance could be prevented if the pupil stopped to think and rationalize. If $x^2 - y^2 = (x + y)(x - y)$, then $1/x^2 - 1/y^2$ should equal $(1/x + 1/y)(1/x - 1/y)$, for $1/x^2$ and $1/y^2$ are numbers just as are x^2 and y^2. Therefore, both cases fall within the rule: *The difference of the squares of two numbers is always equal to the product of the sum and difference of the two numbers.*

Failure to rationalize also accounts for the great increase in errors produced when literal numbers with subscripts are used instead of the usual x and y. Thus, Thorndike found that, while only 18 percent of students failed to find the square of $x + y$, 71 percent failed when the problem was changed to find the square of $b + b$. Two types of error that should be greatly reduced by rationalizing are errors with signs, and errors with processes, which, according to Pease, constitute over half of the total errors made in algebra. It seems clear that many of these errors result from not knowing the meaning of signed numbers and of algebraic processes. Why does -3 subtracted from $+5 = +8$? Why does $-3 + 5 = 2$? Why does -3×-3 or $+3 \times +3 = +9$, but $-3 \times +3$ or $+3 \times -3 = -9$? Why do $+9 \div -3$ and $-9 \div +3 = -3$, and why do $+9 \div +3$ and $-9 \div -3 = +3$? If rational answers could be given to these questions, they might prove to be better preventives of errors than the usual rules, for example, that minus times minus gives plus ($-a \times -b = +ab$).

Such processes can be rationalized by an explanation of the number system in algebra and by pointing out the differences between algebra and arithmetic. In arithmetic the number system begins at zero and continues in only one direction to any desired number, but in algebra it continues in both directions, plus and minus, to any desired number. In arithmetic a number means a certain quantity of units, but in algebra it means so many units away from another number. In arithmetic the 9 in the equation $3 \times 3 = 9$ means 9 units, or 9 units above zero, but the 9 in the algebraic equation $-3 \times -3 = 9$ does not mean 9 units above zero but 9 units in the plus direction from -3; that is, in algebra a number means a certain quantity of units and also that quantity of units away from another number in a certain direction. In arithmetic adding 3 to 5 means counting 3 more than 5, but in algebra it means counting 3 units in one direction or the other from 5 according to the sign. If the sign is minus, it means counting 3 in the minus direction from 5, while if it is plus, it means counting 3 in the plus direction from 5. Therefore $5 - 3 = 2$, and $5 + 3 = 8$. If a given number is -5, then adding $+3$ means counting in the plus direction from -5, and adding -3 means counting in the minus direction from -5, therefore $-5 - 3 = -8$.

In arithmetic, subtracting means taking away or counting from a certain number toward zero, but in algebra it means counting in the opposite direction from that indicated by the sign of the subtrahend, starting from the minuend. Subtracting -3 from 5 means counting 3 units in the plus direction from 5, and subtracting $+3$ from 5 means counting 3 units in the minus direction from 5. Therefore $5 - (-3) = +8$, and $5 - (+3) = +2$. If the minuend is -5, then subtracting $+3$ means counting

3 units in the minus direction from —5, and subtracting —3 means counting 3 units in the plus direction. Therefore $-5 - (+3) = -8$, and $-5 - (-3) = -2$.

In arithmetic, multiplication means finding the sum of a number added to itself as often as there are units in another number, so 3×3 means the sum of three 3's. In algebra, however, multiplication means either adding or subtracting a certain number as often as there are units in another. Multiplicative addition means taking the multiplicand as many times as there are units in the multiplier and in the same direction as its sign. Multiplicative subtraction means taking the multiplicand as many times as there are units in the multiplicand but in the opposite direction from that indicated by its sign. So, $+3 \times +3$ means taking +3 units 3 times, or counting 9 units in the plus direction, or +9; $+3 \times -3$ means taking —3 units 3 times, or counting 9 units in the minus direction, or —9; $-3 \times +3$ means subtracting 3 units 3 times, or counting 9 units in the opposite direction, or —9; -3×-3 means subtracting —3 units 3 times, or counting 9 units in the opposite direction, or +9. So we see that laws of signs can be rationalized. The writer does not mean this rationalization to be a model lesson in directed numbers for presentation to high-school pupils, but rather an illustration of the meaning of the term *rationalize.* The actual presentation should be accompanied by graphic illustrations.

How the rationalizing of processes is applied to the solution of problems may be shown by two examples in J. P. Everett's[10] *Fundamental Skills of Algebra:*

[10] Everett, John P., "Fundamental Skills of Algebra," *Contributions to Education,* No. 324. New York: Teachers College, Columbia University, 1928.

PROBLEM

Solve for x:

$4x + 5 = 17$

$4x + 5$ is a number which equals the number 17. $4x$ is a number, as are also 4 and x.

x is a number whose relation to the rest of the equation is sought.

17 is 5 more than $4x$. Therefore $4x = 17 - 5 = 12$.

12 is four times x. Therefore $x = {}^{12}\!/_4 = 3$.

PROBLEM

Solve for t:

$A = P + Prt$

A is a number which equals the number $P + Prt$. Prt is a number, as are also P, r, t, Pr, and Pt.

t is a number whose relation to the rest of the equation is sought.

A is P more than Prt. Therefore $A\text{-}P = Prt$.

$A\text{-}P$ is Pr times t. Therefore $t = A\text{-}P/Pr$

In this procedure, emphasis is not placed on rules of thumb such as: "Get the x on one side of the equation and the numbers on the other side"; "When transposing, change the signs of the terms"; "Collect terms"; "To find the value of x, divide the number by the coefficient of x," and so forth. On the contrary, the emphasis is placed on the relationships involved, which are always kept in the foreground of attention and which give purpose and meaning to the skills used.

Unfortunately we can point to no experiment showing that rationalized learning is more effective and economical than learning by rule-of-thumb. An actual try-out may prove that it is less so, but the rationalized procedure at least gives meaning to the rules, avoids necessity of accepting them on authority, and makes possible the solution of problems by rational thinking. If this procedure is used in the introduction of new processes and is then followed by systematic drills for developing speed and accuracy, the errors from the wrong use of signs and the confusion of fundamental processes should be greatly reduced.

That we have a right to expect such a result is indicated

in an experiment made by Rugg and Clark.[11] The rationalization of signed or directed numbers and of other algebraic processes was only one of the procedures in their experiment, which included systematic drills with the Rugg and Clark Standardized Practice Exercises; the teaching of all cases in factoring as belonging to one formula: $ax^2 + bx + c$; daily conferences on appropriate content; proper distribution of time and emphasis; best method of rationalizing new material and of reviewing; keeping daily stenographic reports of the conferences and of the work in the classroom; keeping daily records of important difficulties met by pupils, of successful and unsuccessful methods of presenting each type of material, of daily practice in ability to handle formal operations, and of general reasoning abilities with quantitative material; recognizing representation and translation as fundamental operations; and centering all the work around the equation as the core of the course.

The distribution of the time devoted to the various topics was also radically different from the traditional practice. Less than six class periods were given to addition, subtraction, multiplication, and division of algebraic expressions instead of the traditional total of 38; 10 periods were devoted to directed number instead of the traditional 8.3; 6 periods to factoring instead of the traditional 31.4; no time to formal instruction in finding the highest common factor and least common multiple; 4 periods to fractions instead of the traditional 16.6; 41 periods to formulas, translation, and variation instead of no time, as in the traditional course; and constant instead of rare and occasional use of graphic representation, as in the traditional course. In this experiment, traditional

[11] Rugg, Harold O., and Clark, John R., *Scientific Method in the Reconstruction of Ninth-Grade Mathematics.* Chicago: Univ. of Chicago Press, 1918.

means the average number of class periods devoted to topics in first-year algebra in 15 Indiana high schools in 1917. This course with its new content and methods was tried out in two experimental classes for one semester and compared with four traditional or control classes in the same high school, as well as with the average achievement obtained in one year in seventeen other schools.

Although the experimental classes had the emphasis on problem-solving, they were superior in formal operations, developing a greater skill in solving reasoning problems in one semester than the pupils in the traditional schools in one year. Besides, more than three fourths of them mastered the rudiments of functional dependence and understood clearly the principle of constructing formulas. Rugg and Clark concluded that the results definitely show the possibility of saving time by a thorough application of psychology to the learning process in secondary mathematics. Although this experiment is open to criticism because of the great number of variables used in it, it has the distinction not only of being a pioneer piece of work but also of showing that the difference between good and poor teaching can be measured scientifically, and that an important part of good teaching consists of rationalizing the processes.

Solving Verbal Problems

The solution of verbal problems is the vital part of secondary-school mathematics and is said by many teachers to be the source of the most difficulties. The mastery of specific terms and processes is largely a means to proficiency in solving problems. Methods of learning or teaching which will enable pupils to solve problems effectively are, therefore, much sought. A search through the literature on the subject reveals much advice on how to

solve problems, but little or no proof that the advice is good. This phase of secondary-school mathematics has so far received little attention in the way of scientific investigation. We should have studies that reveal the typical errors in verbal problems in algebra, studies of methods used in solving these problems by individual pupils, and studies of the relative values of different methods of solving. But so far, such studies have been limited principally to arithmetic, although there are a few studies that have a bearing on solving verbal problems. These we shall discuss. In advance of such studies we know that in order to solve verbal problems, one must know the meaning of the terms used, be able to read the problem intelligently, be able to select the proper processes for the solution in question, and have mastered the processes which are to be used.

Improving ability to read. Since verbal problems must be comprehended before they can be solved, it is probable that improving reading ability would be helpful in the solution of verbal problems. In arithmetic it was shown in an investigation by Monroe and Engelhart [12] that systematic instruction in reading verbal problems was a help to the duller pupils. The investigations of Lessenger,[13] and of Wilson [14] showed that improving reading ability was accompanied by increased power in solving reasoning problems. Its importance in high-school mathematics is indicated by the correlation between problem-solving ability and knowledge of mathematical terms, which, ac-

[12] Monroe, Walter S., and Engelhart, Max D., "The Effectiveness of Systematic Instruction in Reading Verbal Problems in Arithmetic," *Elementary School Journal,* Vol. XXXIII (1933), pp. 377–381.

[13] Lessenger, W. E., "Reading Difficulties in Arithmetical Computation," *Journal of Educational Research,* Vol. XI (1925), pp. 287–291.

[14] Wilson, Estaline, "Improving Ability to Read Arithmetic Problems," *Elementary School Journal,* Vol. XXII (1922), pp. 380–386.

cording to Lyons[15] is .51. According to Buckingham,[16] the correlation between achievement in reading and ability in algebra depends upon the type of reading. It is high (.71) for reading to predict the outcome, moderate for reading to understand precise directions (.39), and low (.22 to .30) for reading to note details or to appreciate the significance of paragraphs.

The importance of reading ability is also shown in studies of reading difficulties in mathematics. Such a study was made by Georges,[17] who interviewed pupils who had difficulties in interpreting passages and problems in their tests. During a year 218 cases of difficulty were collected and classified into six major types. Georges found that 37.2 percent were difficulties in understanding and interpreting a statement ascribable to the mathematical vocabulary and the mathematical symbolism; 21.1 percent were difficulties in interpreting mathematical processes and relationships because of lack of mathematical background; 10.6 percent were difficulties arising from inability to analyze, such as failure to select the parts necessary to solve a problem and inability to associate the textual explanation with geometric figures; 10.6 percent were difficulties resulting from lack of preciseness in reading, such as omission of parts of a statement and inaccurate reading of familiar phrases; 12.8 percent were due to lack of effort, such as failure to read descriptive material well enough to assimilate or grasp the full meaning of a statement; and 7.8 percent were difficulties arising from the manner in which the exercise

[15] Lyons, Vergil E., *A Study of Certain Difficulties Experienced by Ninth-Grade Pupils in the Solution of Verbal Problems in Algebra.* Master's thesis, University of Wisconsin, 1930.

[16] Buckingham, Guy E., "The Relationship between Silent Reading Ability and First Year Algebra Ability," *Mathematics Teacher*, Vol. XXX (1937), pp. 130–132.

[17] Georges, J. S., "The Nature of Difficulties Encountered in Reading Mathematics," *School Review*, Vol. XXXVII (1929), pp. 217–226.

was stated, such as an exercise containing two problems or one with unexplained abbreviation. In these results it is worth while to notice that over one third of the difficulties are due to the interpretation of mathematical terms and symbols.

Mastering the processes used. Some experiments in arithmetic have shown that a mastery of fundamental processes aids in the solution of reasoning problems, but others have shown no transfer from fundamental operations to the solution of reasoning problems. Correct solutions in reasoning problems cannot be made without a mastery of the fundamental processes, but possession of that mastery does not necessarily improve the ability to solve problems because the student must see how the processes are used and understand their relationship to the solution of the problem before he can solve it. The same is true in algebra. The student must know the processes used, but knowing them is insufficient for solving a problem. Since knowing them is important, we should be familiar with the particular processes that are most frequently used.

A statistical study of the processes used in solving verbal problems in algebra has been made by Bartels [18] of Iowa. He solved all the verbal problems in two widely used textbooks in first-year algebra, then listed all the processes used. He found over 60 different processes ranging in frequency in the two books from 1 to 831. The most frequent, aside from the four fundamental processes, were transposition, collection of like terms, division of integers, removal of parentheses, factoring, multiplication of fractions, clearing of fractions and finding L.C.D., multiplication of decimals, finding square root of mo-

[18] Bartels, Francis D., *The Processes Involved in the Solution of Equations Arising from Verbal Problems in First Year Algebra.* Master's thesis, University of Iowa, 1927.

nomial, and finding square root of integers. The two most frequent types of factoring were the type forms $a^2 + ab$, and $ax^2 + bx + c$. Since these are the processes used in solving verbal problems, it is evident that they are the ones which should be learned.

Stating problems in familiar terms. In arithmetic it has been found that pupils are more successful in solving problems stated in familiar terms than those stated in unfamiliar terms. This is as it should be. If the terms are familiar, the pupil can visualize the objects and situations described and make comprehensible to himself the quantitative relationships involved. If he cannot do this, he often fails to see the point of the problem. An experiment made by Kramer [19] showed that pupils solved 9 percent more problems correctly when they were stated in familiar terms. A similar investigation by White [20] showed that 68 percent of the problems within a child's experience were solved correctly, while only 55 percent of those outside his experience were solved correctly.

Similar experiments in algebra and geometry are not available, but the large increases in errors which have been observed by various investigators when unfamiliar letters or subscripts are used is an indication that the same would hold true in these branches of mathematics.

Training in problem analysis. In arithmetic it has been found that training in problem analysis is an aid to solving reasoning problems. Training was given in finding the given, the unknown, and the processes to be used; estimating the answer in round numbers; studying difficult words; stating problems in their own words, and

[19] Kramer, Grace A., *The Effect of Certain Factors in Verbal Arithmetic Problems Upon Children's Success in the Solution.* Johns Hopkins University Studies in Education, No. 20. Baltimore: Johns Hopkins Press, 1933.

[20] White, Helen M., "Does Experience in the Situation Affect the Solving of a Problem?" *Education,* Vol. LIV (1934), pp. 451–454.

analyzing the meanings. Since all of these devices increase comprehension and help one to see the essential relationships, they should be equally beneficial in algebra and geometry.

Following a logical procedure. Experiments have shown that following a logical procedure is an aid to the solution of arithmetical problems. Such an experiment was made by Newcomb,[21] who instructed pupils to understand each word, read intelligently, determine what is required, select processes that are to be used, and plan the solution. Pupils who followed this procedure made larger gains than pupils who did not have this instruction.

Training in following such a procedure has been found helpful in solving problems in geometry. This was shown in an experiment made by Chastian,[22] who compared this type of assignment with the traditional "proposition and exercise number type," consuming less than one minute. The well-planned assignment consumed about fifteen minutes. The pupils participated in outlining the following four points in the order stated:

1. What is given?
2. What is to be found?
3. Given certain facts, what others follow?
4. Of the facts given, which can be used to reach the desired end?

To solve his problem, Chastian used two equivalent classes of 14 pupils each. None of them had studied geometry before, but all had covered the same amount of algebra, and had been taught by the same teacher. They

[21] Newcomb, R. S., "Teaching Pupils How to Solve Problems in Arithmetic," *Elementary School Journal,* Vol. XXIII (1922), pp. 183–189.

[22] Chastian, Loren, *An Experiment to Determine Relative Values of Different Types of Assignments in a First-Year Geometry Class.* Bulletin of the School of Education, Indiana University, November 1928.

all spent a minimum of 40 minutes in preparation each day and received the same objective tests, which totalled nine for the semester. The tests showed an average score of 58.5 for the class taught by the well-planned assignments, and an average of 49.4 for the class taught by the traditional assignments—a difference of 8.9 in favor of the first. The standard error of this difference was 1.12, which means that the obtained difference was nearly three times larger than necessary for establishing the superiority of the experimental methods.

Giving systematic practice in problem solution. In arithmetic a study made by Washburne and Osborne[28] showed that the assignment of many problems without any special technique was more helpful than the use of formal analysis, such as suggested in a logical procedure, or the use of analogy. In solving many problems, a student cannot help but discover a number of effective techniques, provided that he is successful in reaching correct solutions. This is also in agreement with the law of practice.

Diagramming the problems. In arithmetic the diagramming of problems has been found to be an aid in the solution. It has the advantage of forcing one to think out the essential relationships, to analyze the conditions of the problem, to state what is required, and to figure out the relationship between the known and the unknown, or solution sought. Any device which forces one to think systematically toward a solution and to work out the conditions of a solution should be helpful. Often a solution fails because a student cannot visualize the conditions given. Diagramming overcomes such a deficiency.

Giving practice at the point of error. Numerous experiments have shown that practice applied at the point

[28] Washburne, Carleton W., and Osborne, Raymond, "Solving Arithmetic Problems I and II," *Elementary School Journal,* Vol. XXVII (1926), pp. 219–226, 296–304.

of error is more successful than indiscriminate practice which does not take into account whether pupils are in need of it. Stone[24] has shown that this applied to the solution of arithmetic problems. Experiments showing the value of this procedure in algebra and geometry are not available, but one study has been made showing the principal misconceptions in solving algebraic equations. The experiment was made by Waggoner,[25] who investigated the extent to which ninth-grade pupils comprehend certain main ideas underlying the solution of linear equations having one unknown. He gave tests of equation and statement meanings, equation procedures, algebraic representation, vocabulary, intelligence, and silent reading to 608 pupils from Grade IX who had been taught algebra for eight months. From the results he concluded that the following were the principal interferences and misconceptions:

1. Exponent on one factor of a term applied to a whole term
2. Distinctions between exponents and coefficients not clear
3. Exponents multiplied in multiplication
4. Algebraic expression confused with an equation
5. Integral expression thought of as a fraction
6. Confusion of monomials, binomials, and trinomials with one another
7. Failure to recognize the denominator of an integral expression as 1
8. Confusion of minuend with subtrahend
9. A monomial not thought of as a product
10. The idea that similar terms must have identical coefficients
11. Dissimilar terms collected as if they were similar terms
12. Sign of the term interfering with naming the coefficient
13. Numerical factors considered to be only the coefficients of terms

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[24] Stone, C. W., "An Experimental Study in Improving Ability to Reason in Arithmetic," *Twenty-Ninth Yearbook of the National Society for the Study of Education*, 1930, pp. 569–589.

[25] Waggoner, S. G., *The Ability of Pupils to Interpret Certain Basic Ideas in Linear Equations*. Doctor's thesis, University of Iowa, 1932.

14. The notion that the difference of two algebraic quantities always takes the sign of the larger
15. The belief that the sum of two squares means the square of two sums
16. Indicated sums, products, quotients, and differences tending to lose their identity when buried in equation situations
17. Addition substituted for multiplication
18. Coefficients added in multiplication
19. The notion that finding a common factor means finding a product
20. Common factor confused with common multiple
21. Cancellation applied to terms connected with + and − signs
22. Parts of polynomial factors as well as the whole factor cancel
23. Confusion of denominator with numerator
24. The notion that multiplying a fraction by an integral expression means multiplying both numerator and denominator by the integral expression
25. Addition and subtraction often substituted for the division and multiplication axioms
26. Transposition thought of as adding like terms in each member of an equation
27. The belief that changing the signs of every term in an equation destroys the equation
28. The idea that any algebraic expression to which an equality sign is attached is an equation

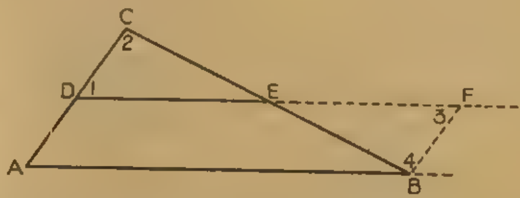
Waggoner stated that the foregoing list of misconceptions reveals that algebra is taught as a series of levers, cranks, and buttons to be pulled and twisted by rule, but managed without understanding, without internal reference, and without insight into the rightness or reasonableness of the processes involved. If this is the case, it is reasonable to suppose that the teacher can help to remedy the situation, not only by emphasizing continually the rational character of algebra, but also by making special efforts to correct the leading misconceptions.

Using a synthetic rather than an analytic method. An experimental study showing that one method of solving a problem is better than another is Pitts's[26] study on the

[26] Pitts, Lemuel, *A Comparison of the Analytic and Synthetic Methods of Teaching Geometry.* Master's thesis, University of Colorado,

comparative value of the analytic and synthetic methods for demonstrating theorems in geometry. In the analytic method we start with the statement to be proved, trace the conditions of the proof, then show that these conditions are true. Thus we say that we can prove x if a equals b and if c equals d; a equals b if m is true, and c equals d if n is true, and therefore x is true. The synthetic method is the usual method which starts from the given and known and deduces the statement to be proved from them. A concrete example will make the differences clearer.

Let us take the following proposition: *A line drawn from the midpoint of one side of a triangle parallel to the base bisects the other side.*



The analytic proof is as follows:

Draw the triangle *ABC* and *DE* from the midpoint of *AC* parallel to the base. Drawing one line parallel to another suggests a parallelogram. So draw *BF* parallel to *AD* and prolong *DE* to *F*.

I can prove that *DE* bisects *BC* if I can prove that *BE* equals *CE*. I can prove that *BE* equals *CE* if I can prove that the triangles *DCE* and *BEF* are congruent. I can prove that they are congruent if I can prove that they have two sides and the included angle equal or two angles and the included side equal. Let us try the first. Angle 3 equals angle 1 and angle 4 equals angle 2, as they are alternate-interior angles of a parallelogram. *BF* equals *DC* because *BF* equals *AD*, as they are opposite sides of a parallelogram. By hypothesis, *AD* equals *DC*. Therefore the triangles *DCE* and *BEF* are congruent and *CE* equals *BE*.

1928. Also *School Science and Mathematics*, Vol. XXXI (1931), pp. 333–339.

The synthetic proof is as follows:

Given: the triangle ABC with DE drawn from the midpoint of AC and parallel to AB.

To prove: that DE bisects BC.

PROOF:

Draw BF parallel to AD and DF parallel to AB; then

	Reason
Angle 4 = angle 2	Alternate interior angles of a parallelogram.
Angle 3 = angle 1	Same reason
$BF = AD$	Opposite sides of a parallelogram.
$AD = DC$	Given
Therefore: $BF = DE$	Axiom
Therefore triangles DEC and BEF are congruent.	Two sides and the included angle equal.
Therefore: $BE = CE$	Axiom.

For solving his problem Pitts used four classes of about 23 pupils each, equated on the basis of an intelligence test and a test on geometry. Two of these classes were taught by teacher S, who used the synthetic method, and two of them were taught by teacher A, who used the analytic method. The classes were selected from a school which had been using the analytic method for about seven years, so that as far as custom was a factor, the synthetic method was favored. Each teacher used the same syllabus and covered the same content but followed different methods for one semester, after which all classes followed the synthetic method. Objective tests were given at definite periods to measure the progress made by each class and the differences between them.

The results were uniformly in favor of the synthetic method. From November to March the analytic class gained 39.9 percent, while the synthetic class gained 60.3 percent; but on May 17 a check test yielded an average of 46.86 for the analytic class and one of 40.12 for the

synthetic class. This was after the analytic class had nearly finished the second semester's work, during which time the synthetic method had been followed. Evidently the change from the analytic to the synthetic method accelerated their rate of progress. Pitts concluded that the analytic method was a hindrance rather than a help in solving new problems, that its mechanics were too difficult for the slow pupils, that the school in which the experiment was tried changed to the synthetic method except for an occasional exercise, and that the synthetic method was more quickly and thoroughly mastered. These conclusions contradict the principal merits claimed for the analytic method, namely; that it is a method of discovery and, as such, gives the key to the solution of originals. Theoretically, the claim of the analytic method as a method of discovery seems justifiable. The synthetic proof cannot be stated until it is worked out by some other method. The psychological way of doing this would be to start with the statement to be proved and trace the conditions of the proof. Having discovered these, it is easy to cast them into the synthetic form. Stopping at the end of the analysis leaves the proof in a rather dark form; if this is the only method taught, the results of Pitts are just what we would expect. Psychologically, the complete proof from beginning to end involves both analysis and synthesis, so actually both forms should be taught. We need an investigation which will determine the value of the combined method compared with either used alone.

Classifying problems into types. The value of using definite procedures for solving verbal problems in algebra is a matter of opinion. Many methods are recommended, but as far as is known to the writer, there is no scientific proof that one is better than another. There are, how-

ever, some guiding principles. Scientific progress is partly a matter of correct classification. The human mind can handle very few facts when dealing with each one singly; but class names, as John Locke said, enable us to handle them in bundles and to master an indefinitely large number. Applying this suggestion to the solution of verbal problems, the difficulties of solving them would be greatly reduced by classifying them into types, finding the fundamental formula for each type, then applying this formula to the solution of the given problem. Such a procedure is recommended by writers on the teaching of mathematics, particularly Powell,[27] and Haertter.[28]

Powell stated that problem analysis reduces to four significant steps:

1. The classification of problems into types
2. The discovery of equality in the general elements of each type
3. The noting of what is required in each problem
4. The examination of the data given.

These steps are illustrated in the following example:

An automobile weighing 2400 pounds is driven across a bridge with a span of 100 feet. How much weight is exerted on each abutment, *A* and *B*, when the automobile is 30 feet from abutment *A*, assuming that the weight of the automobile is concentrated at one point?

1. Classification as to type
   Balance of forces
2. Statement of equality between the elements of this type
   In a state of equilibrium; W_1d_1 equals W_2d_2.
3. What is to be found?
   W_1 on abutment *A*, and W_2 on abutment *B*
4. What do we have to find it with?
   W_1—the weight supported by abutment *A*
   d_1—100 feet, distance abutment *A* is from fulcrum *B*

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[27] Powell, Jesse Jerome, *A Study of Problem Material in High School Algebra.* New York: Teachers College, Columbia University, 1929.

[28] Haertter, L. D., "An Effective Method of Teaching Pupils How to Solve Problems," *Mathematics Teacher,* Vol. XXIV (1931), pp. 166–175.

W_2—2400 pounds, the weight of the automobile
d_2—70 feet, the distance W_2 is from fulcrum B
Therefore $100\ W = 70 \times 2400$, the weight on abutment A.

In a similar manner, replacing A with B and 70 feet with 30 feet, $100\ W_1 = 30 \times 2400$, the weight on abutment B.

The relationship between the weight on each abutment and the distance of the automobile from that abutment may be further developed by pointing out that d_2 may represent any distance between 0 and 100 feet and that, therefore, W_1 may equal any weight between 0 pounds and 2400 pounds.

In a similar manner, Haertter recommends the study of problems by types and the careful presentation to pupils of the fundamental facts and relationships common to such types. His procedure may be illustrated from the following example:

TYPE I. *Uniform Motion Problems*

The fundamental formula underlying all uniform motion problems is d equals rt. The facts given in such problems enable us to form an equation on one of the following bases:

1. Rate equation, two equal expressions for the rate.
2. Time equation, two equal expressions for the time.
3. Distance equation, two equal expressions for the distance.

First analyze the problem and list the facts in a table such as illustrated below. It is easy then to form a rate, distance or time equation.

Illustration: Two express-trains leave New York for Chicago, one two hours after the other. The first train travels 40 miles an hour and the second 50 miles an hour. In how many hours will the second train overtake the first?

Solution: Let t equal the number of hours it will take the second train to overtake the first.

	Distance	*Rate*	*Time*
First train	$40\ t$	40	t
Second train	$50\ (t-2)$	50	$t-2$

$$40\ t = 50\ (t-2)$$

These procedures have the advantage of simplifying the process of solving problems. They make clear the

starting place, the goal to be reached, and the means by which the gap is to be bridged; that is, the equation. Besides, some suggestions are given as to how the equation may be formulated for each type of problem. Such planned solutions should be more effective than haphazard ones, but we shall have to wait for further experiments before we can draw definite conclusions.

Summary

Two important objectives of mathematics are control of our environment and an appreciation of what mathematics has contributed to the progress of civilization. Under control we may include the uses of mathematics in every day life. Under appreciation we may include an understanding of the uses of mathematics in science, in the conduct of big business, and in the manufacture of technical products, such as machines.

Mathematics, like the study of all science or philosophy, is valuable in that it develops abstract thinking. It is particularly well adapted to give training in abstract thinking and to develop the concept of functional relationships.

Mathematics has value as a profession and as a leisure occupation for those who enjoy intellectual activity.

The principle of organization as applied to mathematics refers to those factors by which the subject is made meaningful and by which it is comprehended as a logical system.

Presenting mathematics concretely is one way of making the subject meaningful. Mathematical concepts and processes should be developed from perceptual experience and should be demonstrated realistically whenever possible. This applies not only to fundamental operations for children but also to operations with signed numbers

and geometrical concepts for high-school students. The concrete method of teaching geometry is well adapted to correct the frequent errors resulting from lack of familiarity with common geometrical figures and terms. In addition to being concrete, it has the advantage of supplying a good background for understanding abstract relationships.

Pupils who are taught mathematical concepts inductively from a number of examples and illustrations are superior in comprehension, retention, and power to attack new problems, to those taught by deductive methods.

Instruction by means of detailed unit assignments has been found to produce greater achievement and develop better comprehension in mathematics than the usual group instruction.

A suitable method for reducing the great number of errors arising from lack of insight is to rationalize the processes thoroughly. The experiment by Rugg and Clark, in which emphasis was put on rationalizing processes, solving problems, and a number of other procedures, showed that these methods as used in the experiment are effective.

The following procedures have been found to be helpful for improving ability in solving verbal problems in arithmetic. They should be equally applicable to algebra and geometry, although this yet remains to be demonstrated:

1. Improving the ability to read
2. Mastering the processes used
3. Stating problems in familiar terms
4. Giving training in problem analysis
5. Giving systematic practice in problem solution
6. Diagramming the problems
7. Giving corrective practice at points of error

The analytic method used alone is not as effective in learning how to prove theorems in geometry as is the synthetic. A combination of the two seems better than either one alone.

On theoretical grounds the procedure of classifying problems into types, discovering the fundamental formula for each type, noting what is required in each problem, and examining the data given for the basis of the solution, has much in its favor.

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CHAPTER 19

Mathematics: Practice

The Relation of Practice to Speed and Accuracy

After an individual understands what operations he is to perform in mathematics, he needs practice for the development of speed, facility, and accuracy. Numerous experiments have shown that practice makes enormous differences in these phases of mathematical operations. In arithmetic the experiments of Brown,[1] and of Sister Mary Immaculata[2] showed that short periods of daily drill caused large increases in the efficiency of pupils in the fundamental operations. Brown's experiment showed that five minutes of daily drill for thirty days resulted in a score 15 percent greater than that of the pupils not taking it. In Sister Mary Immaculata's experiment it was found that daily drills from three to nine minutes long for a period of six weeks caused an increase in gains in addition which was five or six times as great as the gains made by pupils who did not have the drill.

Drill is equally effective in algebra. This was shown in experiments by Coit,[3] Armstrong,[4] and Tucker.[5] Coit gave

[1] Brown, J. C., "An Investigation of the Value of Drill in the Value of the Fundamental Operations of Arithmetic," *Journal of Educational Psychology*, Vol. II (1911), pp. 81–88; Vol. III (1912), pp. 485–492, 561–570

[2] Kramer, Sister Mary Immaculata, *Permanence of Improvement and the Distribution of Learning in Addition and Subtraction.* Doctor's thesis, Catholic University of America, 1931.

[3] Coit, Wilbur A., "A Preliminary Study of Mathematical Difficulties," *School Review*, Vol. XXVI (1928), pp. 504–509.

[4] Armstrong, Byron K., "The Effect of Drill in Algebra," *The Mathematics Teacher*, Vol. XXIV (1931), pp. 409–416.

[5] Tucker, Guy E., *The Effect of Specific Drill in Eliminating Errors in the Four Fundamental Processes of Addition, Subtraction, Multiplication, and Division of Algebraic Monomials.* Master's thesis, Northwestern University, 1930.

to groups of high-school and university students problems in addition and subtraction of the following type: Add 8 and -12; $-3a$ and $16a$; $(6a-3b)$ and $(3b-6a)$; $\frac{2}{3}$ and $\frac{1}{2}$. Subtract 3 from -2; 8 from 3; $-\frac{2}{5}$ from $-\frac{3}{7}$. The various groups missed, on the average, from 16 to 30 percent of the examples in addition and from 41 to 63 percent of the subtraction examples. Coit then selected four experimental groups and three control groups having from 21 to 29 pupils each for the purpose of determining the value of drill. The experimental group received 10 minutes of drill a day for 10 successive school days, or a total of 100 minutes, before and after which they were given tests in subtraction. The average initial and final scores for these tests in terms of percent of pupils missing each example were 55.4 and 15.2, 45.6 and 18.6, 59.6 and 7.8, 64.5 and 26.7, for the respective four experimental groups. The corresponding scores for the control groups who received no drill but took the tests were 34.6 and 33.3, 29.2 and 27.3, and 58.0 and 22.4, respectively. Between these two tests the experimental groups made large reductions in their errors, while the control groups made very little, a fact attributed to the influence of drill.

In algebra, Armstrong used experimental and control groups paired for intelligence. The experimental groups received 8 minutes of drill from 3 to 9 times a week for 7 months. At the end of that time, the experimental pupils showed such a superiority over the controls in the Hotz algebra tests that the chances were 89 in a 100 that it was real. The results in Tucker's experiment confirmed those obtained by Coit and Armstrong and do not need a fuller statement. These experiments and those which show the influence of drill on ability in fundamental operations in arithmetic indicate that drill, intelligently used, is one effective way of improving skill in algebra.

Drill for drill's sake is, however, often ineffective. To be effective it must be properly distributed in time; it must cover all combinations and operations involved in the process; it must be distributed according to the difficulty of the combination; it must be mixed so as to provide for sudden changes in the process; it must be applied to the pupil's points of error; it must be integrated with the total process needed for solving problems; and it must be adequately motivated. In the remainder of this chapter we wish to discuss these points more fully.

Distribution of Drill in Time

The effectiveness of drill depends upon how it is distributed in time. An illustration of the influence of this factor is shown in an experiment by the writer [6] who had four groups of college students add for a total of 60 minutes, distributed in four ways: (1) 60 minutes continuously, (2) 20 minutes a day for 3 days, (3) 10 minutes a day for 6 days, (4) 10 minutes every other day for 12 days. The percent of gain in examples right from the first 10 minutes to the last 10 minutes was 12.2, 43.4, 33.6, and 35.1, respectively.

Distribution of Drill in Area

The effectiveness of drill depends upon the extent of area of the activity which it covers. If practice is concentrated upon only part of the operations, the student will be proficient in the operations in which he has been trained but deficient in the others. This effect was shown in an experiment made by Luse,[7] who found that distrib-

[6] Reed, H. B., "Distributed Practice in Addition," *Journal of Educational Psychology*, Vol. XV (1924), pp. 246–249.

[7] Luse, Eva M., *Transfer within Narrow Mental Functions (A Study of the Effects of Distributed versus Undistributed Drill in Arithmetic)*. Doctor's thesis, University of Iowa, 1927. See also Second Yearbook of the National Council of Teachers of Mathematics, Teachers College, Columbia University, 1927.

uted drill yielded 17.7 percent more gain in addition, 18.8 percent more gain in subtraction, 35 percent more gain in multiplication, and 29.9 percent more gain in division than did nondistributed drill. Most writers of textbooks were not aware of this fact and gave the question of distribution little or no attention.

Thorndike,[8] in his *Psychology of Algebra* published in 1923, analyzed the amount of drill in four textbooks. He found little agreement: the number of exercises varied from 41 to 232 for the removal of a negative parenthesis, from 3 to 258 for the addition and subtraction of polynomials, from 61 to 215 for factoring expressions like $x^2 + bx + c$, from 60 to 131 for the solution of simultaneous equations by addition or subtraction, and from 0 to 180 for factoring the difference between two perfect squares. In some cases the amount of practice provided seemed excessive, while in others it seemed insufficient. Cases of excessive practice were 280 examples for factoring the difference between two perfect squares, 1,016 examples for finding the square root of a monomial perfect square, and 1,262 examples for transposing. Cases of insufficient practice were his discovery of no examples at all in one or more books for the following tasks: writing formulas, $a \div bx$, $x \div ax$, $x \div x^2$, $x \div x^3$, $ax \div bx^2$, and $x^2 \div x^3$.

Pease,[9] in his analysis of training units published in 1929, found similar results in three standard texts which he analyzed. The number of drill problems varied from 59 to 127 for addition, from 69 to 106 for subtraction, from 116 to 239 for multiplication and from 66 to 112 for division. One or more of the texts had no drill problems

[8] Thorndike, E. F., *Psychology of Algebra*. New York: The Macmillan Company, 1923.

[9] Pease, Glenn R., "An Analysis of the Learning Units in Processes in Algebra," *Mathematics Teacher*, Vol. XXII (1929), pp. 245–283.

in the following: inverted subtraction, vertical subtraction of literals, horizontal subtraction of literals, removal of parentheses preceded by +, and removal of parentheses preceded by —. Just as there is no agreement about the amount of drill for given operations, so there is none about its distribution.

Thorndike discovered that for finding the least common multiple (including finding the least common denominator of fractions) one book began with a very large amount of practice, then decreased it by irregular amounts at irregular intervals, while another began with a small amount, then gave almost none for a long interval, then a very large amount, and ended with a very small amount. This distribution is typical of those found in other operations. The extreme variations found in these two books cannot both be right; it is practically certain that the second form is a bad one, but how nearly correct the first one is, we do not know. It is unsafe to assume that an operation will be learned when no practice is given in it; there is no guarantee that it will be learned when practice is given, but it is certain that some practice is desirable and that some forms of distribution are better than others.

Distribution of Practice According to the Difficulty of the Task

Practice should be distributed according to the difficulty of the task. Some tasks are much more difficult than others, for example, $8 + 5$ is a much more difficult combination than $2 + 2$. Although a number of studies have been made to show the relative difficulty of the fundamental combinations in arithmetic, similar studies have not been made in algebra or geometry. Most textbook writers in arithmetic provide more drill in easy combina-

tions than in difficult ones. Since the studies showing the differences in difficulty of the various combinations were published, a few texts have appeared which give at least as much practice to difficult tasks as to easy ones. Several studies have been made of the relative difficulty of various tasks of algebra and geometry, which will be referred to later. An effort should be made to distribute the amount of practice according to the difficulty of the tasks.

Mixed Versus Isolated Drill

Experiments in arithmetic have shown that problems requiring a mixture of operations are more effective than problems requiring only one kind of operation. This was the case in an experiment by Repp [10] which showed that either type of drill was profitable but that the mixed drills produced 23 percent greater gain than the isolated. The mixed drills were also more profitable than the isolated for the maintenance of a skill, and yielded greater gains in both speed and accuracy. That the amount of drill should be distributed according to the difficulty of a combination is shown by the fact that more errors are made in certain combinations, such as $7 + 9$, $13 - 4$, 7×0, and $9 - 9$, than in others, such as $2 + 2$, $3 - 3$, 5×1, and $4 - 2$. Similar experiments for algebra and geometry are not available, but it is reasonable to believe that the same rule would hold good. Problems in algebra, like experiments in arithmetic, require frequent shifts from one operation to another. Consequently, drills which require frequent shifting should be more effective than those which do not.

[10] Repp, Austin C., "Mixed versus Isolated Drill Organization," *Twenty-ninth Yearbook of the National Society for the Study of Education,* 1930, pp. 535–550.

Motivated Drill

The need of adequate motivation in learning arithmetic has been shown in several experiments. Chapman and Feder,[11] in an experiment in column addition with 32 children, found that children who were motivated by knowledge of scores, a class chart of daily progress, and rewards for making a greater improvement than the average of the class, increased their score from an average of 14.7 problems in the first ten minutes to one of 20.2 in the last ten minutes, while the corresponding scores of the unmotivated group decreased from 14 to 12.9.

Book and Norvell [12] had a group of 112 college students practice multiplication 1.5 minutes a day, 3 days a week for 15 weeks. The students were divided into two divisions: motivated and unmotivated. The motivation, which consisted of knowledge of scores, and encouragement to do better and to keep a sharp look-out for short cuts, was applied to one group for 30 practice periods. It was then removed and given to the second group, which, up to this time, had been deprived of this stimulation. The motivated group, during the first 30 periods, made a gain of 434 percent, as against 362 percent by the unmotivated group. During the last 15 practice periods the motivated group gained 29 percent, as against 15 percent by the unmotivated.

Panlasigui and Knight found that an experimental class from Grade IV, the pupils of which kept records of their progress from week to week, increased its score from 86.41 to 285.15 during a year, while a control class which had

[11] Chapman, J. Crosby, and Feder, R. B., "The Effect of External Incentives on Improvement," *Journal of Educational Psychology,* Vol. VIII (1917), pp. 469–474.

[12] Book, W. F., and Norvell, L., "The Will to Learn: An Experimental Study of Incentives in Learning," *Pedagogical Seminary,* Vol. XXIX (1922), pp. 305–362.

the same work but without a record of progress increased its score from 86.41 to 273.8. These experiments found the source of motivation in appeals to the mastery impulse. But appeals to social motives are also effective. Hurlock [13] found that praising children for good work done yielded an improvement in addition of 71 percent within one week, as against an improvement of 19 percent during the same time by children who were reproved for poor work. Each of these groups did better than the ignored and control groups, which made small losses in identical work. All these experiments go to show that not just any drill is good, but drill that meets the specific requirements stated.

Practice Applied to Points of Error

Practice applied to points of error is much more effective than practice applied regardless of its need. This should be evident without experimental demonstration, but fortunately we have experiments to prove it. An illustration of the effectiveness of drill applied to the child's points of error is furnished by Buswell and John, who, after having diagnosed the principal errors of over 300 pupils, devised remedial lessons to correct them. They were given during a period of ten weeks, after which a survey test was given to measure the improvement of the pupils. A comparison of the actual gains with the standard gains for ten weeks showed that the former exceeded the latter by 120 percent in addition, 149 percent in subtraction, 213.5 percent in multiplication, and 63.5 percent in division.

That corrective practice applied to the point of error is equally effective in algebra is shown in the experiment of

[13] Hurlock, E. B., "An Evaluation of Certain Incentives Used in School Work," *Journal of Educational Psychology*, Vol. XVI (1925), pp. 145–159.

MacRae and Uhl,[14] who followed the mastery formula in remedial work given after a period of teaching. Those pupils who failed to make perfect scores in the regular test were given remedial work, each according to his needs, and tested periodically until they made perfect scores. Out of twelve pupils in remedial group *B* all but four made perfect scores in the second of these tests. The four who continued made scores ranging between 90 and 96 in the third test. The effect of the remedial work may be judged from the results obtained from pupils 6 and 7. Pupil 6 made scores of 60 in Test I, 68 in Test II, and 90 in Test III. Pupil 7 made scores of 76 in Test I, and 100 in Test II.

Errors in arithmetic. If drill applied to point of error is effective, it is important to know the most frequent errors in arithmetic, algebra, and geometry. One of the best studies made of errors in arithmetic was made by Buswell and John,[15] who conducted an investigation with 515 pupils in Grades III to VI. Thirty-three typical errors were found in addition, 27 in subtraction, 41 in multiplication, and 41 in division. Some of these were far more frequent than others.

The order of the eleven most frequent errors in addition was:

1. Errors in combinations
2. Counting
3. Added carried number last
4. Forgot to add carried number
5. Retracted work after it was partly done
6. Added carried number irregularly
7. Wrote number to be carried
8. Carried wrong number

[14] MacRae, Margaret, and Uhl, Willis L., "Types of Errors and Remedial Work in the Fundamental Processes of Algebra," *Journal of Educational Research*, Vol. XXVI (1932), pp. 12–21.

[15] Buswell, Guy Thomas, and John, Lenore, *Diagnostic Studies in Arithmetic*. Univ. of Chicago, Dept. of Education, 1926.

9. Irregular procedure in column
10. Grouped two or more numbers
11. Split numbers

In subtraction the most frequent errors were:

1. Errors in combinations
2. Did not allow for having borrowed
3. Counting
4. Errors due to zero in minuend
5. Said example backwards
6. Subtracted minuend from subtrahend

In multiplication, the most frequent errors were:

1. Errors in multiplication combinations
2. Errors in adding carried number
3. Writing rows of zeros
4. Carrying wrong number

In division the most frequent errors were:

1. Errors in division combinations
2. Errors in subtraction
3. Errors in multiplication
4. Used remainder larger than divisor
5. Found quotient by trial multiplication
6. Neglected to use remainder within example
7. Omitted zero resulting from another digit
8. Used wrong operation
9. Omitted digit in dividend
10. Counted to get quotient

All the above-named errors were made by 20 percent or more of the pupils, and may therefore be thought of as typical errors. Those peculiar to the individual are more often due to ineffective or wrong methods of working. Examples of such methods are given by Greene and Buswell.[16] A pupil in subtracting 4 from 86 secured 81 for an answer. His method was: "Six and four are ten. Ten

[16] Greene, Charles E., and Buswell, G. T., "Testing, Diagnosis, and Remedial Work in Arithmetic," *Twenty-ninth Yearbook of the National Society for the Study of Education*, 1930, pp. 269–319.

and eight are 18. Turn it the other way makes 81." A pupil from Grade V who was subtracting 36 from 42 gave 14 as an answer. His method was: "Thirty-two to 42 is 10, and four more (32 to 36) is 14." A pupil from Grade V in multiplying 35,897 by 2 gave 719,794 as the product. His method was: "Seven 2's are 14. Seven 9's are 63, and 1 is 64. Seven 8's are 56, and 6 are 62. Five 2's are 10, and 6 are 16. Three 2's are 6, and 1 is 7." This pupil began by using 7 as a multiplier instead of 2 and then later changed to 2, the proper number. These errors are illustrative of difficulties which pupils meet in learning computation in arithmetic. They show the need of methods of learning which will either avoid or overcome them. Since the most frequent error in each of the fundamental operations is "errors in combinations," the first remedy suggested is more drill.

Errors in algebra. A comprehensive study of errors in first-year algebra is the one made by Pease,[17] who collected 43,828 errors of 350 students during the course of a year's work. He analyzed the unit operations in each pedagogical unit, then constructed test problems which involved the unit operations. The students attended four high schools in Iowa and used three texts, namely: Newell and Harper's *A Year of Algebra*, Wells and Hart's *Modern First Year Algebra*, and Schorling and Clark's *Modern Algebra, Ninth School Year*. The tests covered the unit operations in each of these books and were thought to be quite complete. The errors made in the tests were classified into types as shown in Table 26.

It will be noticed that process errors are the most frequent. Next come errors with signs; third, errors due to carelessness; and fourth, errors with exponents. When Pease had classified the errors within each of the four

[17] *Loc. cit.*

TABLE 26

SUMMARY TABLE OF GENERAL ERROR TYPES CONSTITUTING TOTAL PUPIL DIFFICULTY IN N PROCESSES IN FIRST-YEAR ALGEBRA

(From Pease, 1929)

Type of Error	Frequency	Percent of Total
Sign errors	10,046	22.9
Process errors [1]	13,611	31.0
Literal number errors [2]	2,414	5.5
Zero unit errors	1,790	4.1
Exponent errors	3,706	8.5
Combination of terms errors [3]	1,633	3.7
Carelessness errors [4]	3,546	8.2
Unclassified algebraic errors	5,019	11.4
Arithmetic errors	2,063	4.7
Total	43,828	100.0

[1] Contains types of error obtained through using the wrong process, such as: addition when instructed to subtract, use of wrong formula in special products, failing to change sign of subtrahend in subtraction, etc.
[2] Contains such errors as $a + a = a$, $a + a = 0$, $2a - a = 2$, etc.
[3] Contains such error types as failure to combine like terms, and combination of unlike terms.
[4] Contains such errors as omission of letters or terms, errors in copying terms, etc.

fundamental operations, he obtained the results shown in Table 27.

To be noticed is the fact that sign errors are very numerous in each operation. Then there are errors whose frequency is peculiar to the operation: in addition, they are errors with literal numbers and with arithmetic; in subtraction, they consist of using the wrong process; in multiplication, they are exponents and omission of terms; in division they are errors with exponents, and errors of the type $a = a$ or 0. Contrary to the expectations of many, errors in arithmetic comprise a very small amount of the total errors in algebra. This indicates that the two subjects may be relatively independent of each other.

The relative frequencies of errors occurring in mathematical processes have been used by Silas and by Welte to

TABLE 27

SUMMARY OF THE ERROR TYPES CONSTITUTING TOTAL DIFFICULTY IN EACH OF THE FOUR FUNDAMENTAL OPERATIONS IN FIRST-YEAR ALGEBRA

(From Pease, 1929)

Addition	Percent of Frequency	Subtraction	Percent of Frequency
Sign errors	49.6	Sign errors	25.4
Literal number errors	14.8	Process errors	50.2
Column errors	0.3	Errors with zero	5.8
Transcribing	3.4	Literal number errors	6.7
Unclassified algebraic	20 2	Unclassified algebraic	9.0
Arithmetic	11.7	Arithmetic errors	2.9
Total	100.0	Total	100.0

Multiplication	Percent of Frequency	Division	Percent of Frequency
Sign errors	19.8	Sign errors	28.1
Zero unit errors	5.0	Add or subtract	3.7
Add instead of multiply	2.5	Fail to divide numerical coefficient	1.7
Subtract instead of multiply	0.2	Zero unit errors	3.4
Omit numbers or terms	17.6	Number divided by itself or zero	22.3
Exponent errors	27.8	Omit number or term in quotient	3.1
Combination of terms errors	8.1	Exponent errors	6.7
Use of wrong formula errors	5.0	Combinations of terms errors	1.1
Unclassified algebraic errors	11.7	Divide only one term of sum or difference	8.1
Arithmetic errors	2.2	Divide both terms of a product	8.0
Total	100.0	Unclassified algebraic errors	10.7
		Arithmetic errors	2.7
		Total	100.0

determine the relative difficulty of tasks in algebra and geometry, respectively. Silas[18] made up a set of 32 drills covering 72 skills that had been isolated as representative of the first year's work in algebra. These drills were administered to about 15,217 pupils from Grade IX located in 21 different states and in 61 experimental centers. From the results the 150 most difficult exercises were selected. These furnished a total of 30,566 errors, exclusive of omissions. Out of the analysis and organization of these errors, there were selected 38 type errors as representative of all the errors in the 150 exercises. They are listed below in their order of frequency from least to greatest. These give the teacher an idea of how to distribute his effort.

1. Common monomial factor, what to do with it, after being recognized
2. Miscellaneous
3. Recognition of "in lowest terms" or "simplest form"
4. Polynomials, division of by monomials
5. Recognition of an equation
6. Recognition of symbolism
7. Recognition of requisite operation
8. Directed numbers, operations with (where sign errors were outstanding)
9. Trinomial, or binomial, factoring
10. Arithmetical concepts, e.g.: *int., prin., am't., consecutive, odd,* etc.
11. Parentheses, removal of, and writing
12. Recognition of subscripts
13. Expansion
14. Equations, simultaneous
15. Polynomials, subtraction of
16. Algebraic concepts, e.g.: *similar terms, absolute value,* etc.
17. Equation, writing an (with conditions given)
18. Recognition of common monomial factors
19. Exponents, operations with
20. Roots, extracting
21. Radical form, changing to exponential

[18] Silas, Paul Gordon, *Difficulty in First Year Algebra.* Doctor's thesis, University of Iowa, 1932.

22. Formulae, evaluating where values for all but one unknown are given
23. Equation, integral linear, literal and numerical (in one unknown), solution of
24. Equation, quadratic
25. Denominate numbers
26. Functional graphs, reading and making
27. Arithmetical errors
28. Ratio and proportion
29. Symbolism, expressing relation in (other than equations)
30. Fractions, division of and by
31. Formulae, solution of (finding one letter in terms of the others)
32. Fractions, multiplication of and by
33. Recognition of product of two binomials having corresponding similar terms
34. Statistical graphs, reading and making
35. Recognition of product of sum and difference of two numbers
36. Polynomials, division of by polynomials
37. Fractions, adding and subtracting
38. Locating errors in a problem

Studies of errors in first year algebra have also been made by Buckingham,[19] Gilliland,[20] Dickinson and Ruch,[21] Rugg and Clark,[22] Scott,[23] MacRae and Uhl,[24] and others. Comparisons are difficult because no two classified the errors in the same way, and some of them studied the errors only in certain processes. The errors found by Buckingham are interesting because, as far as they go, they

[19] Buckingham, G. E., *A Study of the Nature, Frequency and Persistence of Errors Made by Students of First-Year Algebra in the Four Fundamental Processes of Addition, Subtraction, Multiplication and Division of Monomials.* Master's thesis, Northwestern University, 1930.

[20] Gilliland, Gladys, *Kind, Frequency and Persistency of Errors Made in Factoring in First-Year Algebra.* Master's thesis, Northwestern University, 1930.

[21] Dickinson, E. L., and Ruch, G. M., "An Analysis of Certain Difficulties in Factoring in Algebra," *Journal of Educational Psychology,* Vol. XVI (1925), pp. 323–328.

[22] Rugg, Harold O., and Clark, John R., *Scientific Method in the Reconstruction of Ninth-Grade Mathematics.* Chicago: Univ. of Chicago Press, 1918.

[23] Scott, Flora L., "Repetition of Errors in Algebra," *Mathematics Teacher,* Vol. XVIII (1925), pp. 92–96.

[24] *Loc. cit.*

confirm the findings of Pease. Gilliland and Dickinson, and Ruch limited their studies of algebraic errors to the process of factoring. Gilliland finds the most frequent errors in factoring to be: "common monomial factor was not taken out," for example, $3b^2 - 3b - 6 = (3b - 6)(b - 1)$; "signs in a quantity not changed when parenthesis, preceded by a minus sign, was removed," for example, $a^2 - (b - c)^2 = (a - b - c)(a - b - c)$; "terms instead of whole processes were factored," for example, $ab + ac = a{\cdot}b + a{\cdot}c$.

Dickinson and Ruch gave particular attention to the difficulties created by the use of unusual literal factors and of subscripts, as in formulas in physics: $v_t = v_o + at$ (falling bodies); $F = G(mm'/D^2)$ (gravitation); and $pv = p^1v^1$ (Boyle's Law). They found that the factoring of such problems as $(\frac{1}{2}\,hb_1) + (\frac{1}{2}\,hb_2)$, $.4x - .8y$, and $Rs + sR + Sr + sr$, was very much more difficult than such problems as $5a + 5b$, $mx - my$, and $aq - ar + qx - rx$, although mathematically there is little difference.

Rugg and Clark calculated the frequency of errors in each of the principal procedures, including exponents, quadratic equations, radicals, and practical formulas. In exponents the most frequent error was of the type, $(X^3)^4 = X^7$. In quadratic equations the most frequent errors were finding only one root, as $X^2 - 81 = 0$, $X = 9$; and not completing solution, as $X^2 - 81 = 0$, $X - 9 = 0$, $X + 9 = 0$. In simplifying radicals the most frequent error was leaving a factor having the same power as the degree of the radical, as $\sqrt{32} = 2\sqrt{8}$. In solving practical formulas, the most frequent errors were: "error in division, result inverted," for example, $V = lwh$, $w = hl/V$; "error in selecting coefficient of the unknown" as in $L = mt - g$, $m = Lt/(t - g)$ [considers $(t - g)$ as coefficient M]. Scott discovered that in a series of prob-

lems repeated daily for a week the errors repeated amounted to about 80 percent, a fact indicating that once an error is made it tends to persist.

Causes of errors in algebra. These numerous errors in algebra show that a few processes are effectively learned, but that most of them are poorly learned. The reasons for these errors lie partly in the complexity of the processes, partly in the methods and materials of learning, and partly in the learner. That algebra is complex is shown by the fact that Pease has analyzed over 500 different learning units in first-year algebra, each of which must be mastered before the pupil becomes efficient in the subject. During the learning processes it is inevitable that some of these units should become confused with each other or interfere with each other.

The high frequency of errors with signs, errors arising from the confusion of fundamental operations, and errors with exponents shows that directed numbers, fundamental operations, and operations with exponents are not well taught. The fact that some processes are so well taught that only two to four pupils in 100 make errors in using them, while in others over 60 pupils in 100 make errors indicates that the materials of instruction are far from being what they should be. Possibly some important learning units are overlooked, while others are overemphasized.

There are psychological factors in the individual which predispose him to errors. One of these is insufficient intelligence. Buckingham, and MacRae and Uhl found a fairly close relationship between frequency of errors, and the size of the individual's intelligence quotient. When Buckingham's pupils were divided into quartiles, he found that the I.Q.'s ranging from 71 to 103 made 498 errors, that those ranging from 112 to 117 made 267 errors, and

that those ranging from 118 to 130 made 133 errors in a test given six weeks after the beginning of a course. Similar results were found for each of the other fundamental operations.

In another test given after 24 weeks it was found that the high I.Q.'s made relatively much larger reductions in their errors than the low I.Q.'s. For example, in addition the I.Q.'s ranging from 71 to 103 reduced their errors to 301 while the I.Q.'s ranging from 118 to 130 reduced their errors to 32. Here also similar results were found for all the other fundamental operations.

Habit is another factor which leads to errors. In subtracting -3 from 5, the pupil gets 2 because in arithmetic it was thoroughly drilled into him that $5 - 3$ is 2. A pupil is satisfied with one value for x in a quadratic equation because in all his previous learning about simple equations, that was correct. $(X^3)^2 = X^9$ because in arithmetic $3^2 = 9$; and $(X^3)^4 = X^7$ because $X^3X^4 = X^7$.

In many cases the pupil makes errors because he responds to only part of a situation instead of to the whole of it. For example, in clearing fractions he may multiply only one side of an equation so that $(x/4) - (3x/2) = 6$. Not infrequently errors are fostered because wrong manipulations accidentally result in the correct answer. In such cases a favorable attitude towards the repetition of those errors is created.

A very important cause of errors is lack of insight into the operations. When $-4(x - 6) = -4x - 24$, the pupil may not understand that he is to subtract 4 times a quantity which is 6 less than a certain number or that the subtraction of $4x$ is 4×6 too much, or that the make-up for this deficiency requires the addition of 4×6 or $+24$. The quantity $(X^2)^3$ may give X^5 because the pupil may not understand that $(X^2)^3$ means $X^2 \cdot X^2 \cdot X^2$, and $(m\,n^2)^2 =$

mn^4 because the pupil may not understand that $(mn^2)^2$ means $m^1 \cdot m^1 \cdot n^2 \cdot n^2$ or m^2n^4. One reason for this lack of insight may be the fact that algebra is sometimes taught as a series of manipulations or rules or as a bag of tricks instead of as a meaningful language or logical system of thought.

It is also evident that many errors result from the fact that many processes are not fixed because of insufficient practice. Examples of this are persistent errors in the addition or subtraction of exponents, in the signs of terms when a parenthesis preceded by a minus sign is removed, in the collection of like terms, or in confusing addition and subtraction. These causes suggest remedies in the form of well-designed and systematic drills, effective methods of presentation and explanation, better organization, due consideration of the mental level of the learner, and a better construction of the materials of instruction with reference to the difficulties of learning.

Errors in geometry. A study of errors in plane geometry was made by Welte,[25] who collected 10,000 papers from 2,000 high-school pupils on 5 different exercises. The errors in 4,000 of these papers were analyzed and ranked by frequency in order of difficulty. In 2,000 papers he found a total of 26,986 errors. Given below is the order of frequency from greatest to least for the first 32 of these errors.

1. Application of theorems and corollaries other than to specific figures, and also involving computation
2. Stating what is given in a theorem
3. Stating fundamental axiom for given condition
4. Stating converse of theorem
5. Stating fundamental theorem for given condition
6. Identification of statements of theorems

[25] Welte, Herbert D., *A Critical Study of Errors in Plane Geometry.* Doctor's thesis, University of Iowa, 1929.

7. Application of theorem and corollaries other than to specific figures, not involving computation
8. Application of theorems and corollaries to specific figures, and also involving computation
9. Stating fundamental theorems for steps in proof
10. Stating what is to be found in a theorem
11. Stating kind of geometrical figure from given conditions
12. Identification of parts of a polygon
13. Judging accuracy of a statement
14. Application of axioms, postulates, and so forth, other than to specific figures
15. Identification of kinds of polygons
16. Identification of kinds of angles
17. Completion of statement of theorem, corollaries, and so on
18. Identification of parts of angles
19. Identification of included sides, included angle, and so on
20. Selection of correct words of definition (matching exercises)
21. Application of theorems to specific figures, not involving computation
22. Application of axioms, and so forth, to specific figures
23. Stating reasons other than theorems, for steps in proof
24. Identification of parts, lines, and so on
25. Identification of parts of a circle
26. Fact omissions
27. Selecting correct steps in proof of a theorem
28. Identification of symbols and abbreviations
29. Computation of size of angles
30. Computation of areas of polygons applied to specific figures
31. Miscellaneous
32. Computation other than areas not applied to specific figures

The causes of the errors made in plane geometry are suggested by the errors themselves. Inability to identify symbols and abbreviations, inability to identify parts of a circle, parts of angles, kinds of angles, parts and kinds of polygons, and so on, suggests lack of familiarity with common geometrical figures and terms. Inability to identify the included side or angle or to select the correct words of a definition suggests lack of technical vocabulary. Inability to state what is given, what is to be found, the converse of a theorem, or the completion of a theorem

partly given means that the pupil does not comprehend the language used. Inability to state the theorem underlying given conditions means that he cannot see the relationship between the particular and the general. Inability to apply axioms, theorems, propositions, and corollaries to other than specific figures indicates a lack of generalization. The meaning of a given theorem is tied up with a particular figure given in the book; when that figure or its lettering is changed the application becomes imperceptible. In fact, all these apparent causes suggest two general causes: lack of knowledge and lack of insight; the latter points to a possible need of a high mental level for the successful pursuit of demonstrative geometry.

These errors and their causes suggest the following remedies: the use of much constructive work with accurate naming and lettering of parts; the inductive derivation of definitions; the isolation of the technical words in the subjects and systematic drills for teaching their meanings; the application to the reading of geometrical propositions of devices commonly used for increasing comprehension in beginning reading; and the use of a variety of figures in connection with each theorem for the purpose of increasing generalization. We shall discuss some of these in connection with methods.

Summary

When the use of mathematical processes is understood, practice is useful for developing speed, facility, and accuracy.

Pupils who have daily systematic drill for brief periods develop more skill than those who lack this practice.

Drill is effective, but drill for drill's sake is not good. To be effective, it must be applied to the pupil's points of

error; it must be properly distributed in time and according to the difficulty of the combination; it must cover all the combinations and operations; it must be mixed so as to provide for sudden changes in process; it must be properly integrated with total processes needed for solving problems; and, finally, it must be properly motivated.

The distribution of drill is widely ignored by the authors of the materials of instruction. There appears to be no plan for its proper distribution in time or in proportion to the difficulty of the operation, or for adequately maintaining skills. There also appears to be no plan for making sure that adequate drill is provided for all the learning units.

Studies of errors in high-school mathematics are very important psychologically because they show where the learning process goes wrong and where it needs correction and guidance. In algebra the most frequent errors have to do with signs and the confusion of processes. Literal-number errors are prominent in addition, exponent errors in multiplication, and errors in dividing a number by itself in division.

Another value of the study of errors is that it makes it possible to find the order of difficulty of the various topics to be learned. According to this criterion, recognizing a common monomial factor is an easy task; and locating errors in a problem, a very difficult task.

Among the causes of errors in algebra are the complexity of the processes, low intelligence, habit, the custom of responding to a part of a situation and ignoring its effect on the whole, occasional success through manipulation of processes, lack of understanding or insight, the teaching of algebra as a bag of tricks, and lack of systematic drill.

Among the most frequent errors in geometry are those

in the application of theorem other than to specific figures, in stating what is given in a theorem, and in stating the fundamental axioms for a given condition.

The causes of errors in geometry appear to be lack of familiarity with common geometrical figures and terms, failure to understand the language of geometry, inability to generalize and to classify, and lack of insight.

Supplementary Reading

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CHAPTER 20

Mathematics: Individual Differences

Individual differences in achievement in mathematics vary in relation to age, grade, sex, intelligence, and race of the individual. Within each of these groups the scores vary widely with individuals. The efficiency of instruction in mathematics depends to a large extent upon how well it is adjusted to such differences. It is the purpose of this chapter to describe the principal differences in achievement in relation to each of the above-mentioned factors and to show some methods of adjusting the instruction to them.

Differences in Relation to Age

The number abilities of children begin at age two, and from that point on they increase with the child's mental development. At two the average child can count 1, but during the next four years there is a very rapid increase in his knowledge of numbers. By the time the average child is six or six and a half years old he can count to 25 or 30; he can recognize groups of objects varying from 2 to 10 in number, and he can recognize the more common coins, such as penny, nickel, dime, quarter, and half dollar. He also knows a few simple combinations, such as $5 + 1$, $2 + 2$, and $4 + 6$. It is difficult to compare the number abilities of young children with those of older ones because the same tests are usually not given to six-year olds as to those who are eight years old or older. However, the scores on Test II in Army Alpha make it possible to compare the number abilities of eight-year-old pupils and

sixteen-year-old pupils. This test consists of twenty verbal problems, which are graduated in difficulty. It has a time limit of five minutes. The median score for boys age eight to nine is 2.4 problems, while that for boys age sixteen is 9.9 problems. This shows an immense increase in power to solve problems between these ages.

In the development of number concepts the child's mind usually goes through a definite number of steps. Number ability is shown first in counting real objects. The next step is the recognition of groups of objects supplemented by counting; for example, the child may recognize a group of six objects as 4, and then count 1—2; and a group of 8 objects as 5, and then count 1—2—3. The third step is independent group recognition, when the child recognizes groups of a certain size directly without counting. The fourth step is the perception of meaning of symbols, such as 5 or 12. Since these are the psychological steps by which number concepts are developed, it would seem reasonable to follow such a procedure in developing number concepts through instruction.

Differences in Relation to Sex

In relation to sex, tests consisting of reasoning problems usually produce a difference in favor of boys, while those consisting of computation often give a difference in favor of girls. For example, in the Army Alpha, at age sixteen the median for boys is 9.9, while the median for girls is 8.7. Heilman,[1] who made a careful investigation of sex differences with the Stanford Achievement Test administered to ten-year-old children equated in social and economic status, found small differences in favor of girls for computation and in favor of boys for reasoning prob-

[1] Heilman, J. D., "Sex Differences in Intellectual Abilities," *Journal of Educational Psychology*, Vol. XXIV (1933), pp. 47–62.

lems. Grossnickle [2] found significant differences in favor of boys in knowledge of arithmetical concepts. Touton [3] who investigated sex differences in ability to solve originals in geometry, found no differences in the median scores, although he found a higher percent of boys than girls who made a perfect score. Webb,[4] and also Foran and O'Hara,[5] found differences in favor of boys in ability to do tests in geometry, when the two sexes were equated for mental ability. Perry,[6] who also investigated this problem, found that boys were slightly superior in reasoning ability, but that girls reached superior achievement. In general, we may say that the most significant fact about these differences is their small amount. They are too small to justify segregation of pupils in mathematics on the basis of sex.

Differences in Relation to Mental Level

A pupil's ability to solve mathematical problems is closely related to his mental level. Washburne [7] stated that not to take account of this fact is to doom many children to failure, and to do so adequately is to insure a reasonable success. According to his investigation a mental age of six years and five months is necessary to

[2] Grossnickle, F. E., "Concepts in Social Arithmetic for the Eighth Grade Level," *Journal of Educational Research*, Vol. XXX (1937), pp. 475–488.

[3] Touton, Frank C., "Sex Differences in Geometric Abilities," *Journal of Educational Psychology*, Vol. XV (1924), pp. 234–247.

[4] Webb, P. E., "A Study of Geometry Abilities among Girls and Boys of Equal Mental Abilities," *Journal of Educational Research*, Vol. XV (1927), pp. 256–262.

[5] Foran, T. G., and O'Hara, Br. Colombiere, "Sex Differences in Achievement in High School Geometry," *School Review*, Vol. XLIII (1935), pp. 357–362.

[6] Perry, Winona M., "Are Boys Excelling Girls in Geometric Learning?" *Journal of Educational Psychology*, Vol. XX (1929), pp. 270–279.

[7] Washburne, Carleton W., "The Grade Placement of Arithmetic Topics: A 'Committee of Seven' Investigation," *Twenty-ninth Yearbook of the National Society for the Study of Education*, 1930, pp. 641–670.

learn the addition facts of sums up to ten; a mental age of seven years for the 50 easier subtraction facts; a mental age of eight years and four months for multiplication facts; a mental age of ten years and nine months for simple division; and a mental age of twelve years and four months for percentage. The exact mental level for these operations would depend a good deal upon the particular tests that were used, the manner of administration, and the amount and kind of previous instruction. In spite of the influence of such variables, there still remains the significant fact that different mathematical operations require different levels of mental ability to perform. We should have similar investigations to tell us the relation of mental level to the various types of work that must be done in algebra and geometry. There is no doubt that simple exercises in substitution require a lower mental level than the solution of equations with one unknown, and that quadratic equations require a higher mental level than simple equations. But what is the mental level for each of these operations? We do not know. Investigations, however, have been made of the amount of mental level that is necessary for success in algebra as a unit course.

Thorndike,[8] after analyzing considerable data, came to the conclusion that an I. Q. of 105 to 110 is necessary for success in algebra. Schreiber [9] reports that of the students studied by him only 6 percent passed who had an I. Q. below 90. He found that the average mental age of 27 pupils who failed was 13 years, 7 months; that their median I. Q. was 95, and that their average score in

[8] Thorndike, E. F., *Psychology of Algebra.* New York: The Macmillan Company, 1923.

[9] Schreiber, Edwin W., "A Study of the Factors of Success in First-Year Algebra," *Mathematics Teacher,* Vol. XVIII (1925), pp. 65–78, 141–163.

Otis S. A. Higher Examination was 31.7. On the other hand, those who passed had an average score of 45 or a mental age of 15 years, 10 months, and an I. Q. of 110.

Jackson[10] reports that in the high school of Mount Hermon, Massachusetts, correlations between I. Q., as determined by the Otis and Dearborn intelligence tests, and standing in first-year algebra at the end of the year have been carefully calculated over a period of three years. He found that 65 percent of those below an I. Q. of 100 fail, that 40 percent of those with I. Q.'s between 100 and 110 fail, that 34 percent of those with I. Q.'s between 110 and 119 fail, and that 20 percent of those with I. Q.'s above 120 fail.

Wood[11] tried to teach algebra to students who had previously failed in the subject. Their I. Q.'s ranged from 70 to 112. He concluded that such efforts are a waste of public money. However, in our discussion of individual methods we shall find that Stokes,[12] using the Winnetka plan, taught algebra successfully to a class whose average I. Q. was 93. From these results, it is difficult to come to a definite conclusion. To do so, it will be necessary to investigate the percent of failure for each mental age from 13 to 18. It appears, however, that a mental age of at least 15 is necessary to handle the subject with a reasonably good chance of success.

Achievement in Relation to Periods of Disuse

Skill in mathematics is not exempt from the law of forgetting. With disuse and the lapse of time, it gradu-

[10] Jackson, N. A., "Learning in First-Year Algebra," *School Science and Mathematics,* Vol. XXXI (1931), pp. 980-988.

[11] Wood, O. A., "A Failure Class in Algebra," *School Review,* Vol. XXVIII (1928), pp. 41-49.

[12] Stokes, C. N., "Comparing the Effect of Arithmetic and General Mathematics in the Seventh and Eighth Grades upon Achievement in the Ninth Grade General Mathematics," *School Science and Mathematics,* Vol. XXX (1930), pp. 853-857.

ally fades away. This is shown in an experiment made by Layton,[13] who was interested in finding out the amount of algebra retained over a period of one year during which no mathematics was studied. She gave the New York State Regents' Examination for 1928 to 51 pupils from Grade IX, in May 1929, June 1929, and May 1930. Between May and June, 1929, a month's intensive review of the year's work was given to the class. Between June 1929 and May 1930 no mathematics was studied. The test consisted of two parts. Part I was a comprehensive test of the manipulative techniques, and was so constructed that it allowed no partial credits. Part II was on the applied side of the subject, consisting of verbal problems, and allowed no partial credits.

The results showed that during the eleven months of no study of algebra, the total score decreased about 37 percent; that for the manipulative processes the decrease was about 10 percent more, and that for the verbal problems it was about 9 percent less. In general, we may say that about two fifths of the skill attained at the end of a year of elementary algebra was lost during the following year of no study. On the other hand, a month's review at the end of a year of study added about 20 percent to the skill attained at the beginning of the review. According to other studies, most of the forgetting during the first year occurs during the first three months. Stokes[14] found that one fourth was forgotten during this time, while White[15] found that the amount varied from

[13] Layton, E. T., "The Persistence of Learning in Elementary Algebra," *Journal of Educational Psychology*, Vol. XXIII (1932), pp. 46–55.

[14] Stokes, C. N., "Sustained Application in Ninth-Grade Mathematics," *Journal of Educational Research*, Vol. XXI (1930), pp. 364–373.

[15] White, Annabel L., *The Retention of Elementary Algebra through Quadratics after Varying Intervals of Time*. Washington, D. C.: Judd and Detwiler, 1932.

one fourth to one half. After this the rate of forgetting is slow.

The amount forgotten during the interval between the end of the first year of high school and the beginning of the first year of college has not been exactly measured. Some idea, however, may be obtained by comparing the average scores of college freshmen with norms established for Grade IX. Such a comparison was made by Eells,[16] who gave the Hotz algebra tests to 81 freshmen in Whitman College. The results showed that the freshmen who had had one year of algebra in high school made scores about one half as high as the norms for nine months of study. Those who had had one and one-half years of algebra made scores about two thirds as high. On the basis of these results, we may say that of the amount learned from two semesters of the study of algebra, one half is forgotten in three years. If a third semester of algebra is studied during the junior year of high school, the amount forgotten will be reduced from one half to one third. According to other studies, forgetting after two years is much less than that indicated by the above results. Wulff[17] found that after three years of no formal study of algebra pupils could regain in about three hours the achievement obtained at the end of the first year, while Mason[18] found that the amount retained after several years of no study of the subject varied from 75 to 90 percent, which seems very large.

In geometry the forgetting is comparable with that in

[16] Eells, Walter Crosby, "What Amount of Algebra Is Retained by College Freshmen?" *Mathematics Teacher*, Vol. XVIII (1925), pp. 219–225. Also "How Much Algebra Is Remembered by Freshmen When Entering College?" *Ibid.*, Vol. XIX (1926), pp. 206–221.

[17] Wulff, Margaret Ann, *The Retention of Junior High School Mathematics*. Master's thesis, University of Minnesota, 1932.

[18] Mason, Nellie C., *A Study in the Retention of Junior High School Mathematics*. Master's thesis, University of Minnesota, 1932.

algebra. Arnold[19] found that 80 percent of the college freshmen whom he tested were below the median of high-school students, that 57 percent were below their 25th percentile, and 32.5 percent were below their 10th percentile.

In arithmetic, the amount forgotten between Grade VIII and the freshman year of college is very great. Although no exact measurements have been made, we can form some idea by comparing the percent of college freshmen who reach the various grade norms in arithmetic. Such a comparison was made by Lueck.[20] He gave the Compass Survey test in arithmetic to 200 students in first-year college physics in five Iowa colleges, then calculated the percent who attained each of the established grade norms. A total of 120 of these students had taken or were taking courses in college mathematics.

Only 20 percent attained the norm for Grade VIII and only 57 percent exceeded the norm for Grade Low VII. Considering that physics usually attracts students who do unusually well in mathematics and science, we may assume that their average in Grade VIII was at least the equal of the 75th percentile for that grade. If so, we may say that during their years in high school they forgot the equivalent of at least two years' gain in the upper grades.

While these results do not make possible accurate statements about the rate of forgetting mathematical skill, they at least indicate that forgetting does occur and that the amount of first-year algebra forgotten will vary between one third and two thirds in three years if it is

[19] Arnold, H. J., "Abilities and Disabilities of College Students in Elementary Algebra," *Journal of Educational Research*, Vol. XXIII (1931), pp. 324–329.

[20] Lueck, Wm., "How Much Arithmetic and Algebra Do Students of First-Year Algebra Really Know?" *School Science and Mathematics*, Vol. XXXII (1932), pp. 998–1006.

not studied in the meantime. Two practical conclusions that may be drawn from these results are that a third semester of algebra adds much to the pupil's skill and that the college teacher must review the subject from the beginning.

Differences in Relation to Grade Level

The relation of grade position to achievement in mathematics may be seen from the grade norms of any standardized test in mathematics, the ones presented in connection with the discussion of retention being typical examples. In general, they show that the higher the grade position, the greater the achievement in mathematics. This does not mean that there is any inherent or logical connection between the two but only that the

Addition

(3)

$$\begin{array}{r} \$386.85 \\ 96.66 \\ 6.57 \\ 100.00 \\ 5.94 \\ \underline{60.00} \end{array}$$

(9)

.07 + 5.23 + 8.29 + 1.40 =

Subtraction

(12)

$$\begin{array}{r} 880.75 \\ \underline{785.78} \end{array}$$

Multiplication

(23)

$$\begin{array}{r} 769 \\ \underline{708} \end{array}$$

(37)

½ of 3 bu., 2 pk., 2 qt.

Division

(39)

$78\overline{)12418}$

The answer has not been pointed off. Place decimal point in answer where it belongs.

(48)

$$\begin{array}{r} 456 \\ .123\overline{)560.88} \end{array}$$

two go together. The relation of grade position to achievement in arithmetic all the way from Grade V to Grade XII, inclusive, may be seen from results obtained by Schorling, who gave a test consisting of 100 exercises to 3,545 pupils distributed over these grades. The writer has selected seven of these exercises to illustrate their character, retaining Schorling's numbers (page 525).

The scores on each of these exercises together with the lowest, highest, 25th percentile, 50th percentile, and 75th percentile give a good picture of the relation between grade position and achievement in arithmetic. These results are given in Tables 28 and 29.

TABLE 28*

PERCENT OF CORRECT RESPONSES OF 3,545 PUPILS IN GRADE V TO XII INCLUSIVE ON 7 TASKS IN ARITHMETIC

(From Schorling, 1931)

Grade	Number of Pupils	Percent of Correct Responses						
		Task (3)	Task (9)	Task (12)	Task (23)	Task (37)	Task (39)	Task (48)
5	622	46.5	4.7	44.3	30.2	0.0	21.6	0.5
6	636	47.2	25.2	59.2	40.2	0.2	29.4	1.8
7	638	55.2	28.5	72.9	54.5	1.3	41.5	3.4
8	633	65.4	51.8	78.2	58.8	8.8	43.2	16.2
9	335	67.5	60.0	84.5	69.3	9.2	50.3	27.2
10	236	70.0	68.8	84.7	66.2	15.2	44.0	19.9
11	230	73.3	64.2	87.4	68.1	21.1	45.1	20.0
12	215	82.2	71.2	89.9	72.8	38.2	57.6	27.6

* Tables 28, 29 and 31 are from Schorling, Raleigh, "The Need of Being Definite with Respect to Achievement Standards," *Mathematics Teacher*, Vol. XXIV (1931), pp. 311–329.

There is a rapid increase in ability up to Grade VII, but after that, the increments from year to year are much smaller. The increase from Grade IX to X is much less than the increase from Grade VIII to IX. In view of the fact that nearly all high-school students take a unit of mathematics in the ninth year, the reverse should be true.

The increments after Grade VII are possibly due to the factor of selection rather than to increased ability in arithmetic. The degree of mastery in Grades VII and VIII is very low: 39.8 and 43.8 out of 100. Even in Grade XII the median is but 67. The chances are 3 out of 5 that a given example will be done incorrectly in Grades VII and VIII and 1 out of 3 that it will be done incorrectly in Grade XII.

TABLE 29

NORMS FOR GRADES V TO XII INCLUSIVE FOR A TEST OF 100 TASKS IN ARITHMETIC. PERCENT OF CORRECT RESPONSES

(From Schorling, 1931)

Grade	Number of Pupils	Percent of Correct Responses			Score	
		75th Percentile	Median	25th Percentile	Lowest	Highest
5	622	34.2	17.6	12.3	1.0	51.0
6	636	28.8	22.0	17.6	3.0	70.0
7	638	50.6	39.8	30.4	6.0	86.0
8	633	54.2	43.8	35.0	9.0	91.0
9	335	59.8	48.6	39.9	5.0	94.0
10	236	62.3	51.7	42.6	12.0	92.0
11	230	72.2	59.0	46.0	16.0	96.0
12	215	81.9	67.0	54.3	22.0	94.0

A test which shows the achievement in algebra in relation to length of study is the Illinois Standardized Algebra test, which consists of four parts, I, II, III, IV. All parts consist of equations of the first degree. Test I has one unknown only on one side; Test II has unknowns on both sides; Test III has parentheses on both sides; and Test IV has fractions on both sides. The norms for the ends of semesters I, II and III are given in Table 30.

That high-school pupils are far from reaching standards of perfection has been shown in the results given on retention. Additional evidence on this point is furnished

TABLE 30

NORMS FOR ENDS OF SEMESTERS FOR NUMBER RIGHT IN ILLINOIS STANDARDIZED ALGEBRA TESTS

(From Monroe and Williams, 1920*)

Semester	Number of Pupils	Norm				Maximum Score
		Test I	Test II	Test III	Test IV	
1	420	.5	4.6	3.6	1.0	20.0
2	530	6.4	6.4	5.5	3.8	20.0
3	86	8.7	8.3	7.3	5.7	20.0

* Published by Public School Publishing Co., Bloomington, Ill.

by the results of a test consisting of the fundamentals of arithmetic and algebra given to 2,693 college freshmen by Schorling. The following table gives a few selected items from his results:

TABLE 31

PERCENT OF CORRECT RESPONSES GIVEN BY 2,693 COLLEGE FRESHMEN ON A TEST IN THE FUNDAMENTALS OF ARITHMETIC AND ALGEBRA

(Selected from Schorling, 1931)

No.	The Test Item	Percent Correct Responses
	Part I—Arithmetic	
5.	What is the average of 4, 11, 66, 0, 9?	71
6.	What is the sum of 75/9 and $4\frac{1}{2}$?	78
8.	Multiply $2\frac{1}{2}$ by $3\frac{1}{2}$	66
9.	Divide $3\frac{1}{2}$ by 13/4	74
10.	What is the square root of 10609?	39
12.	What percent of 25 is 75?	28
	Part II—Algebra	
1.	If d is the cost per dozen, what is the cost of one?	81
4.	What are the factors of $6x^2 + 7x + 27$?	42
10.	Add $1/a + 1/b$	27
	Part III—(presumably a power test)	
1.	Write as a power of 12 the number of cubic inches in a cubic foot	34
3.	The sum of two numbers is 102; the greater exceeds the smaller by 6. What is the greater number?	65
11.	The digits of an integer are a and b. If the products of the digits equals a/b, what is b numerically?	7

These results, together with those on retention, show that mathematical skill increases with advancement through the grades during the period of study. When study ceases, skill again deteriorates. The practical implication is that the achievement attained is very mediocre; this raises such questions as the following: What can be done to obtain higher and more uniform achievement in essentials? It is justifiable to measure achievement in terms of units of study and to define prerequisites in terms of units of previous study?

Relation to Other Subjects

The relation of achievement in mathematics to achievement in other school subjects is interesting from the standpoints of the relation between abilities, of prediction, and guidance. Paxton [21] investigated the correlation of achievement in algebra to achievement in grade-school subjects, while Crathorne [22] investigated the correlations of achievement in algebra and geometry to achievement in other high-school subjects. Paxton based her investigation on the grades of 156 boys and 170 girls. She found that the achievement of boys in algebra correlated .57 with arithmetic, .51 with English, .58 with foreign language, .48 with social science, and .07 with manual training. Crathorne based his calculations on the grades of boys and girls in six schools. He found that, in the case of boys, achievement in algebra correlated .47 with English, .52 with geometry, .50 with German, .53 with Latin, .47 with history, and .36 with civics. He found also that achievement in geometry correlated .43 with English, .36 with stenography, and .34 with manual

[21] Paxton, Margaret, *Predicting Success in Junior High-School Algebra.* Master's thesis, Leland Stanford University, 1930.

[22] Crathorne, A. R., "The Theory of Correlation Applied to School Grades," *Report of Reorganization of Mathematics in Secondary Education,* 1923, Chapter X.

training. Richardson[23] reported a correlation of .70 between second-semester algebra marks and first-semester geometry marks; Hamilton[24] reported a correlation of .63 between average marks in algebra and English for a group of 87 students and a correlation of .78 for another group of 88 students.

These results indicate that ability in mathematics is not an isolated affair and that the best prediction of success in mathematics can be made from marks in previous courses in the subject. Aptitude tests in algebra and in geometry are useful, too, and when combined with other tests such as mental-ability, or with trait-rating scales, are nearly as good as marks in previous courses.[25]

Remedies for Poor Achievement in Mathematics

The cure for poor achievement is adequate learning. Experiments on memory have shown that retention is improved by overlearning or by perfect mastery of the facts, adequate drill, proper distribution of the drill, reducing the quantity to be learned, learning with the intention to remember, understanding well the processes learned, adequate organization and integration of the facts, and by connecting the facts with the life purposes of the learner. Very few of these principles are applied satisfactorily to the presentation of the content of mathematics. Most texts give ample materials for drill, but little attention is paid to its distribution. The processes are inadequately explained; they are not integrated well

[23] Richardson, H. D., "Predicting Achievement in Plane Geometry," *Mathematics Teacher*, Vol. XXVIII (1935), pp. 310–319.

[24] Hamilton, J. Landon, "A Method for Reducing Failures in Plane Geometry," *Journal of Educational Research*, Vol. XXX (1937), pp. 700–702.

[25] Lee, J. Murray, and Hughes, W. H., "Predicting Success in Algebra and Geometry," *School Review*, Vol. XLII (1934), pp. 188–196. Also "A Study of Prognosis of Probable Success in Algebra and Geometry," *Mathematics Teacher*, Vol. XXVII (1934), pp. 165–180, 225–246.

with the central objectives of the course; too many topics are given for mastery; and little attention is given to connecting the facts with the life purposes of the learner.

Adequate attention to principles of learning will also correct, to some extent, defects in the mastery of fundamentals. When only 57.6 percent of high-school seniors can correctly divide 12418 by 78 and only 34 percent of college freshmen can write as a power of 12 the number of cubic inches in a cubic foot, something is wrong with the mastery of fundamentals. One is inclined to believe that such conditions are due to a failure to take school tasks seriously or to lack of motivation, or to failure to pay attention to the principles of learning discussed above. The more likely cause, however, is lack of definiteness in the goals to be attained. Nobody knows just what is to be learned; therefore many things are studied but few are mastered. When the number of examples one student does correctly out of 100 varies from 5 to 94, as in Grade IX, or from 22 to 94, as in Grade XII, the custom of giving these two students the same amount of credit because they spent the same amount of time in class is called in question. The same is true in regard to the assumption that both have met the prerequisites to an advanced course. Such cases show that reckoning educational achievement in time units must soon give way to reckoning it in units of mastery.

Achievement in Relation to Individual Differences Within a Grade

The most important differences in achievement from the standpoint of instruction are those within a grade. If the reader will again turn to Table 29, which gives grade norms from Grades V to XII, he will see that the differences between the highest and lowest scores are

very large. For example, in Grade VII the highest score is 86.0, and the lowest, 6.0. In Grade XII, the highest score is 94.0, and the lowest, 22.0. The lowest score in Grade XI is below the median of Grade V, and the highest score in Grade VI is above the median of Grade XII. The difference between the highest and lowest scores in each grade is larger than the difference between the medians of Grades V and XII. This means that within each grade the teacher must adjust the instruction to seven grade levels of ability or their equivalent. This, again, is a demonstration of the inadequacy of mass instruction differentiated by grade levels.

Causes of Individual Differences in Mathematics

The causes of individual differences in achievement in mathematics are not peculiar to this subject except insofar as they relate to differences in experience and in instruction in numbers and in quantitative relationships. For the most part, the causes are the same as those which account for differences in other types of achievement, such as differences in intelligence or brightness, mental level, interest, effort, reading ability, achievement in related subjects, and in instruction. The importance of brightness is shown by the fact that the correlations between I. Q. and achievement in either algebra or geometry average about .50. The importance of mental level and of reading ability has already been discussed; the importance of interest and effort has been shown in studies on motivation, and the importance of instruction was pointed out in the discussion of individual differences in the social studies. One bit of evidence indicating that it applies also to mathematics is contained in the studies of the relation of class size to achievement in algebra. Jensen found that, during a semester, a group of boys in

a large class made an average gain of 20.10, while an equivalent group in a small class made an average gain of only 9.74 points. Haertter, on the other hand, found little difference between large and small classes, but he used different methods of instruction in the two groups.

Methods of Adjusting the Instruction to Individual Differences

After we see how wide individual differences are in mathematics, we realize the importance of devising methods of instruction which will be adjusted to them. A number of methods have been investigated. These include supervised study, ability grouping, individualized instruction, differentiated assignments, special methods for slow pupils, and the case-study method for those having serious disabilities.

Supervised study. In supervised study there is an opportunity to adjust the instruction to individual needs. Because of this fact it has been found to achieve superior results.

Some forms of supervised study improve achievement in arithmetic. Minnick [26] found that a class in geometry which had done all its studying during a period following the recitation did about 12 percent better in the final examination at the end of a semester than another class which had had no supervised study. During the supervision an effort was made to teach the pupil how to study. In an experiment by Jones [27] the pupils in algebra were divided on the basis of mental age, educational age, and accomplishment quotient, as determined by standardized tests. Parts of the Hotz and Douglass tests were given

[26] Minnick, J. H., "An Experiment in the Supervised Study of Mathematics," *School Review*, Vol. XXI (1913), pp. 670–675.

[27] Jones, Harry Vincent, *Measured Results of Supervised Study in Ninth-Grade Algebra*. Master's thesis, University of Colorado, 1927.

at the end of each unit during the semester. All these showed from 3.1 to 14.1 percent difference in favor of the supervised group. At the end of the year the Hotz test and the Douglass, Form *A*, test showed differences in favor of supervision, but the Douglass, Form *B*, test showed a small difference in favor of the nonsupervised group. These results indicate the necessity of further experimentation before definite conclusions can be drawn. As stated in previous discussions of this method, its value depends upon what is done during the supervision. Unless an experimenter states clearly what procedures he used during supervision, his results have little value for the guidance of others.

As to whether supervised study should precede or follow the recitation, the experiment of Douglass [28] showed that in mathematics it should precede the recitation. At this time the explanation of new processes is still fresh in the minds of the pupils, making it possible to use them successfully.

The socialized presentation combined with the project method and supervised study has been found to give excellent results in correlated mathematics. An experiment on this method was carried on by W. H. Johnson [29] in the Lane Technical High School, Chicago. Two beginning classes from Grade IX and two from Grade X were used, one class from each grade being used as an experimental class and one as a control class. The classes were paired on the basis of the Otis Self-Administering Tests of Mental Ability. In the control classes, the ordinary routine of question-and-answer recitations was carried on, the prep-

[28] Douglass, Harl R., "Study or Recitation First in Supervised Study in Mathematics Classes?" *Mathematics Teacher*, Vol. XXI (1928), pp. 390–397.

[29] Johnson, W. H., "The Socialized Recitation in the High School," *School Review*, Vol. XXXII (1924), pp. 682–687.

aration being done at home. In the experimental classes, the first part of the period was devoted to determining the value of the next topic to be studied. This often led to a discussion of the methods of study to be used, for example, the method of developing theorems inductively by experimentation on the use of the inductive method in showing the congruency of two or more triangles. The outcome of this discussion was the selection of a project. This was followed by a period of supervised study for solving certain problems connected with the project. The class then turned to a socialized discussion of the work planned and completed during the previous study. The main features of this part were: (1) a statement of the project, (2) constructive criticisms by the pupils, (3) changes of leaders for the discussion, and (4) evaluation of the answers and criticisms given by classmates. Subject-matter tests were given at intervals of five weeks throughout the semester to all the classes. The scores in these tests show differences of 3 and 4 points on a scale of 100, in the first tests, to differences of 13 and 15 points at the end of the semester in favor of the experimental classes; but these differences do not disclose the enthusiasm that is said to have been shown by the experimental pupils.

In this experiment, we have several factors that favor learning: the goal was consciously and voluntarily selected; the means of reaching it were not selected until there had been a good deal of group discussion of various possible methods; there was pupil-activity in the class, and the responsibility for leadership was upon the pupils. All of these make for intense effort toward the goal.

Homogeneous grouping. Grouping students into classes according to ability reduces the number of failures in high school and seems to benefit particularly the low

and average students. Mensenkamp[30] found that where there are 100 students or more in beginning algebra the proportion of failures could be reduced two thirds by dividing them into four sections according to ability. In his plan the lowest group was offered arithmetic and the others algebra, the chief difference in the work of the various sections in algebra being one of intensity.

A controlled experiment on the value of grouping students according to ability in plane geometry for the second semester was carried on by Bohner,[31] who had five classes—three homogeneous, and two mixed. The homogeneous classes were divided according to ability into slow, average, and fast on the basis of four factors: intelligence quotients, mental ages, teachers' marks, and objective tests. The mixed or control classes contained pupils of all grades of ability. A total of 97 pupils took part. The general plan for all five classes was the same, but in the homogeneous classes the content differed in intensity; the methods were adapted to the pupils; and the fast pupils were given supplementary work. The progress of each class was measured by objective tests given every four weeks to all the pupils. The results of these tests showed that the slow and average pupils made greater gains in the homogeneous classes than in the mixed classes, but that the fast pupils made greater gains in the mixed than in the homogeneous classes. The slow pupils profited far more than the average pupils by the segregation.

The experimenter thought that the results were not fair to the superior pupils because the tests used had not been constructed for measuring them adequately. An-

[30] Mensenkamp, L. E., "Ability Classification in Ninth-Grade Algebra," *Mathematics Teacher*, Vol. XXII (1929), pp. 34–38.

[31] Bohner, Clarence A., *A Study of Ability Grouping in Second Semester Plane Geometry*. Master's thesis, University of Minnesota, 1928.

other probable fault in this experiment was an inadequate differentiation in the content for the different grades of ability. Other experiments have shown that grouping according to ability provides only a partial solution to the problem of individual differences. It reduces the range of ability to which given methods and materials must be adapted, but within each group there are still wide differences in rate of learning, interests, and needs. These differences may be met more adequately through flexibility in the instruction rather than through homogeneous groupings of the learners. Such flexibility is found in the individual-instruction and differentiated-assignment plans.

Individual instruction. How an adaptation of the individual-instruction, or Winnetka plan, enabled a class of 18 pupils whose average I. Q. was only 93 to pass the second semester of algebra without a single failure is told by Stokes[32] of the New Township High School at Kenilworth, Illinois. In view of the fact that from 30 to 40 percent of the pupils in first-year algebra ordinarily fail, this is quite an achievement. In an attempt to reduce the number of failures, Stokes followed the Winnetka plan of individual instruction. The course was divided into seven main divisions, each of which was subdivided into small units or goals according to the subject matter. On each goal 25 practice exercises were prepared, each preceded by sufficient explanatory material to enable the pupil to solve them. These exercises were intended to enable the pupil to pass the goal and were arranged in cycles of four so that any error or weakness might be definitely located. Each exercise also had a set of answers arranged so that the pupil could correct his own mistakes.

[32] Stokes, C. N., "Individual Instruction in Ninth Grade Algebra," *Mathematics Teacher*, Vol. XVIII (1925), pp. 209–218.

For each goal there was a test which covered the area of the goal completely and which was also sufficiently diagnostic to locate the nature of the pupil's weaknesses. The pupil was promoted in the course as he passed the goals. There was no failure, as the success in reaching one goal was relied on to motivate the pupil toward mastery of the next one. Each pupil was allowed to pass the goals as fast as he could. No one marked time.

Special methods for slow pupils. High-school mathematics usually requires better than average intelligence for its successful study, but average pupils, or those born short, or those who have fair ability but are too lazy to use it may learn mathematics by means of special methods and materials, such as those used by Miss Hildebrandt [38] of the Proviso Township High School. She does not follow a textbook but begins the work in plane geometry with simple constructions, giving definite directions which must be read accurately and carried out step by step. Often one pupil does the work while another directs his movements. During this time, geometrical terms are thoroughly explained and pupils are required to understand but not to memorize them. The pupils are next taught the value of a neat proof and that every theorem must be read for an understanding of three things: (1) a figure, (2) an hypothesis or definite statement with which to work, and (3) a conclusion or definite statement to be proved. When a theorem is discussed, it is definitely labeled according to its utility; that is, whether it can be used to prove angles equal, triangles congruent, or line segments equal. Accuracy in speech is much stressed. If a theorem is incorrectly stated, pupils must show that it is incorrect, and why. Much time is also given to in-

[38] Hildebrandt, Martha, "Adapting Plane Geometry to Pupils of Limited Ability," *Mathematics Teacher*, Vol. XVIII (1928), pp. 102–110.

dividual study habits and to individual corrective work. These methods are good not only for slow pupils; if they were used more extensively with good pupils they should prevent many of the errors frequent even among the latter group.

The case-study method. The needs of some individuals cannot be met adequately by individualized forms of group instruction. In this group are found those pupils who continue to show no progress, fail to respond in class, turn in very inaccurate work, make excessive use of the trial-and-error method, and seem to have little comprehension of the tasks assigned. These should be treated by the case-study method. Since there are no comprehensive diagnostic tests for algebra and geometry, the diagnosis of difficulties in mathematics should be made by the informal interview method, in which the teacher assigns various types of problems, observes how the pupil works them, and asks him for explanations of the processes used. This information should be supplemented by a case history and by scores made in standardized tests of intelligence, reading, mathematical vocabulary, and survey tests in the subject studied. The remedies must be prescribed on the basis of the information found. About the only rule that can be given in advance is that some form of individual instruction should be used. An idea of the nature of these individual cases may be obtained from two case reports selected from a study made by MacRae and Uhl,[34] who gave special attention to individuals not profiting from the class instruction:

Case II. Boy. 15 years old. I. Q. 103. Placed in the A group; later transferred to the D group. No apparent ability to generalize. Had to be retaught the principle with each new application of it.

[34] MacRae, Margaret, and Uhl, Willis L., "Types of Errors and Remedial Work in the Fundamental Processes of Algebra," *Journal of Educational Research*, Vol. XXXVI (1932), pp. 12–22.

Negative quantities always gave him trouble. Memory poor, and he forgot the regular details for the heading of his papers. Was willing and anxious to understand the work. Had too many extra-curricular activities.

Had "no time" to come for special help. Arrived just in time for school in the morning; went home at the noon intermission; practiced with the orchestra after school. Manifested a feeling of hurry which increased toward the close of school. Did the best he could under the circumstances. Given credit for the year's work in algebra. Recommended not to take geometry.

Case III. Boy. Age 15 years. I. Q. 132. Group A. Small for his age and sensitive about it. (Brother two years younger is taller and much heavier.) Never ready to begin, a putterer. On timed tests the last to start and never completed a test. Daydreamer. Slow reader of problems and would speed up only under pressure. Knew arithmetical combinations. Signs used apparently haphazardly. Logical thinker in verbal problems. Oral recitation better than written. Given drill in the mechanics of getting ready to start test. Required to have necessary tools ready when he came to class. Personally supervised to force his attention and prevent waste of time when directions were given. Needed strong stimuli. Monthly grade of "P" aroused him to the danger of failure and acted as a spur.

Summary

Achievement in mathematics varies in relation to the individual's age, sex, length of period of disuse, mental level, grade level, achievement in related subjects, and differences from another individual within each of those groups.

A child of two years has some notion of number. From this point mathematical ability increases rapidly during the period of growth. The average six-year old can count up to 25 or 30, can pick out groups of objects up to 10, and knows simple combinations such as $2 + 2$. An average child sixteen years old can do from four to five times as many verbal problems in five minutes as one who is eight years old. In developing number concepts, the individual begins with counting, goes through a stage of group recog-

nition, then recognizes the meanings of abstract numbers.

Sex differences in mathematical ability are small and have little practical importance. Girls have a slight advantage in computation, and boys a slight advantage in solving reasoning problems.

A certain mental level is necessary for success in algebra. A pupil having an I. Q. below 90 has 6 chances in 100 of passing the course; one with an I. Q. below 100 has 35 chances in 100; one with an I. Q. below 110 has 60 chances in 100; one with an I. Q. below 120 has 66 chances in 100; and one with an I. Q. above 120 has 80 chances in 100 to pass the course. The minimum mental level necessary for success cannot be accurately stated, but it appears to be about 15 years for first-year algebra. It is probably a year more for demonstrative geometry.

Skill in mathematics is subject to the law of forgetting. Accurate measurements have not been made, but comparisons between the average achievement of pupils who have finished mathematics for Grade IX and that of freshmen at the beginning of college indicate that about one half of the amount learned is forgotten. Such tests also indicate that college freshmen lose the increments gained in arithmetic in Grades VII and VIII. In geometry the achievement of college freshmen drops about the distance between the median and the 25th percentile of their achievement in Grade X. College freshmen who have had a third half-unit in algebra in Grade XI show a much better achievement than those who have studied only one year in Grade IX.

The forgetting of mathematical skill could be greatly reduced by due attention to better methods of learning and of review. The fact that forgetting occurs makes it necessary for the college teacher to reteach the whole subject.

Achievement in mathematics, in relation to grade position, increases with advancement through the grades during the period of study, but it begins to deteriorate when the study ceases. Most of the apparent advancement in arithmetic after Grade VIII appears to be due to the factor of selection.

The most remarkable facts about the achievement of college freshmen are their mediocre ability in fundamentals and their wide variation. This shows a dire need of better methods of learning, as well as the necessity of stating the specific goals to be mastered.

The most important differences from the standpoint of instruction are those among individuals of the same group or grade level. Each grade appears to require in itself as wide an adaptation in instruction as that between Grades V and XII. Among the types of instruction recommended for meeting the needs of individuals are supervised study, homogeneous grouping, individualized instruction, differentiated assignments, and special methods for slow pupils.

Pupils studying mathematics under supervised study make better scores than do those who do not.

Homogeneous grouping in mathematics makes it easier to meet individual differences. It has been found to reduce the number of failures.

Individual instruction according to the Winnetka plan has been found to be a means of teaching algebra successfully to pupils having I. Q.'s below 100.

Slow pupils have been found to be able to learn geometry by the use of special methods which emphasize simple construction, detailed and clear directions, accurate drawings with accurate naming and lettering, accurate speech and the reading of theorems for three points: a figure, an hypothesis, and a conclusion.

The case-study method is recommended for those indi-

viduals not profiting from other types of instruction. This method requires a diagnosis by the informal interview method, followed by individual instruction prescribed for the needs revealed.

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CHAPTER 21

Mathematics: Motivation and Materials

The teaching of mathematics may be motivated by appeals to mastery motives, such as knowledge of results and use of tests; by appeals to social motives, such as praise, blame and rivalry; by providing interesting activity; and by selecting content which meets both the requirements of learning and the needs of individuals. Experiments made in learning arithmetic have shown the value of these types of motivation. Students who are accurately informed about the results of each practice period learn more rapidly than those who are simply told to do their best but are not informed about the results. Students whose weekly progress is scaled and measured reach a higher achievement during a semester's or year's work than do those whose work is not scaled. Students who are praised do much better than those who are scolded, although either praise or blame is better than being ignored. In the primary grades it has been found that presenting arithmetic through playing store and games is much more effective than the academic presentation. Content which meets the requirements of learning, such as mixed drill, proper temporal distribution of drill, proper distribution of drill according to difficulty of task, and ease of understanding is more rapidly and effectively learned than material which does not meet these requirements. In high-school mathematics we may expect the same types of motivation to be effective. We shall discuss

more fully two forms of motivation, namely: motivation through the use of tests and motivation through the selection of the material.

Motivation Through the Use of Tests

Knowledge of improvement is always an effective way of motivating learning. This applies to mathematics as well as to other subjects. Knowledge of this improvement may be obtained through teachers' marks, through standardized tests, or through informal objective tests. The difficulty with teachers' marks is that they are too variable to give accurate information. This was shown in a final examination paper in geometry which was duplicated by Starch and Elliott [1] and sent to 119 teachers to be graded. The grades on this paper by the various teachers varied from 28 to 92. Because of such variability, there is no certainty that a low mark means loss of or lack of skill, nor that a high mark means gain or possession of skill. Standardized and informal objective tests overcome this deficiency to a large extent, as they have greater reliability and sample the field more fully. Instead of containing 10 to 20 questions, they usually contain from 70 to 100 questions. Ruch and Stoddard [2] found that the correlation between the odd- and even-numbered questions for the old-type or essay examination, or coefficient of reliability, ranged from .35 to .90, with a median of .55. Wood [3] found that the coefficient of reliability for the old-type examination in mathematics of the New York State Regents was .63. Against this, the reliability

[1] Starch, D., *Educational Psychology*. New York: The Macmillan Company, 1929.

[2] Ruch, G. M., and Stoddard, Geo. D., *Tests and Measurements in High School Instruction*. Yonkers, N. Y.: World Book Company, 1931.

[3] Wood, Ben D., "Studies of Achievement Tests," *Journal of Educational Psychology*, Vol. XVII (1926), pp. 1–22, 125–139, 263–269.

of standardized tests in mathematics is frequently above .90.

The principal objection to standardized tests is that they can be given only at relatively long intervals, such as two or three times a year. For this reason they are well adapted for measuring improvement over a long period of time, for making surveys, and for finding the facts upon which to form instructional programs and policies. They are not well adapted for measuring the mastery of a unit of instruction occupying several weeks, or for discovering the specific weaknesses in that unit. That is, the standardized achievement tests in mathematics help little to guide the instruction from day to day or from week to week. It is here that informal objective tests and diagnostic tests have their value.

A second objection to the standardized tests which have so far appeared is that all the items are devoted to the measurement of skills. There are no items for measuring the appreciation which the pupil has acquired of the meaning of mathematics to the history of civilization, or the new insights that he has acquired in his environment. As long as these are ignored in the curriculum, there is little use of putting them in tests.

So far, no satisfactory diagnostic tests have been published for high-school mathematics. Some achievement tests are diagnostic in the sense that they enable the teacher to locate a weakness within a given operation such as addition, multiplication, or factoring, but not in the sense that a specific weakness in an operation can be identified—which is what a genuine diagnostic test should do.

We hope that we shall have such tests in the near future, but in the meantime much can be accomplished by the use of informal objective tests made by the teacher.

These may be just as extensive and as reliable as the standardized tests, yet have the advantage of being adapted to the particular unit or series of units studied by the pupils. Investigations have been made of the reliabilities of informal objective tests in geometry by Baum[4] and by Macune.[5] Baum found that her coefficients of reliability ranged from .73 to .98, while Macune found that hers ranged from .77 to .96. The groups to which the tests were given had more to do with the size of the correlation than did the kind of new-type test used.

A new-type test may be poorly made just as it may be well made. How these new-type tests may be used to aid the realization of objectives in a course in mathematics and in the improvement of instruction may be illustrated from the testing program used in East High School, Rochester, New York, and described by Welton.[6] In this school, a member of the department acting as "subject chairman" prepared an informal objective test which was given to each of the classes in first-year algebra. The teacher of each class, after giving the test, reported the number of pupils solving each question to the subject chairman, who summarized the results of the work of all the classes and reported them to the teachers as quickly as possible so that remedial work might be begun. In making these tests due regard was paid to the central objectives of the course. Items were selected and weighted in proportion to their relevancy to these central objectives. How this was done is shown in the credits

[4] Baum, Kathryn E., *The Comparative Value of Old and New-Type Examinations in Plane Geometry*. Master's thesis, University of Texas, 1928.

[5] Macune, Katherine, *Comparative Values of New-Type Examinations in Plane Geometry*. Master's thesis, University of Colorado, 1927.

[6] Welton, P. L., "A Testing Program in Elementary Algebra and Its Evaluation," *Mathematics Teacher*, Vol. XXIV, 1931.

assigned to the various topics of the semester test, as follows:

1. The language and ideas of algebra		4 percent
2. The formula		
(a) The use of formulas	9	
(b) Making formulas	11	20
3. Fundamental principles and processes		
(a) Addition	2	
(b) Subtraction	2	
(c) Multiplication	7	
(d) Division	7	
(e) Addition and multiplication	2	
(f) Combining terms and removal of parentheses	4	24
4. The equation		16
5. The graph		8
6. Problem solving		
(a) Geometric	7	
(b) Numbers	7	
(c) Business	7	
(d) Motion	7	28
		100 percent

The fundamental importance of functional relationships was emphasized by assigning 72 percent of the credits to questions involving them. In this way their importance became translated into habit and did not remain simply an interesting topic for theoretical discussion. The summarized report showed the median of each class and aided in the stimulation of rivalry. It also showed the number of pupils who attempted each question, the number, and the percent who solved each one correctly.

This program is said to have produced better results in the skills and in the fundamental objectives of mathematics. We should have, however, a controlled experi-

ment to show the results of such a procedure in comparison with the results in equivalent classes which do not use it. In such a program attention should be given to all types of problems which were solved by less than the median number of pupils.

Motivation Through the Selection of the Material

The important questions to ask about mathematical material from the standpoint of motivation are: (1) Does it make the principal objectives easily realizable? (2) Does it meet the needs of the pupil? (3) Is the quality such that it can be easily learned? (4) Is the quantity such that it can be readily mastered? (5) By what criteria shall suitable content be selected?

Are the objectives easily realizable? In discussing the first question it is proper to quote again the statement of the National Committee[7] that "the primary purposes of the teaching of mathematics should be to develop those powers of understanding and of analyzing relations of quantity and of space which are necessary to an insight into and control over our environment and to an appreciation of the progress of civilization in its various aspects, and to develop those habits of thought and of action which will make those powers effective in the life of the individual." To find out whether the content now taught in secondary-school mathematics is suitable for realizing these purposes requires an exact analysis of the specific contents from the standpoint of their relativity to these purposes. At present such studies are not available. An examination of textbooks gives the reader the impression that the emphasis is almost entirely upon the mastery of particular processes. There is an occasional illustration

[7] National Committee on Mathematical Requirements, *The Reorganization of Mathematics in Secondary Education*. The Mathematical Association of America, Inc., 1923.

or problem on an applied phase of a certain fact and an occasional remark about the importance of a fact, such as the Pythagorean proposition, but the objective of developing through mathematics an insight into our environment and an appreciation of the progress of civilization is certainly not in the foreground. What mathematics has done for the progress of science, the dispelling of superstition, and the development of industrialism is, in most cases, no better understood after the pupil has had his arithmetic, algebra, and geometry than before. If this side of mathematics may be said to constitute its cultural value, we can say that the latter is very much ignored. But from the standpoint of social utility in the broad sense, the cultural value is much more easily defended than its practical value, and should, therefore, be brought into the foreground. If the curriculum is measured by its suitableness for giving the individual practical control over his environment, we would say that, judging from its character and quantity, it has every appearance of being adequate for this purpose so far as control is possible by mathematics. But the test of this is a practical one: can the pupil do accurately the processes that he has studied? The numerous studies of errors to which we have referred show that the mastery of mathematics far from gives the pupil any practical control over his environment. But whether the cause of this is in the curriculum, in the learner, or in the methods of teaching cannot be stated.

Does the material meet the needs of pupils? The question whether the material in mathematics meets the needs of pupils can be answered from the numerous studies of the uses of mathematics. The study of mathematics may be useful for the pursuit of other high-school subjects, for the pursuit of college subjects, for reading, and for profes-

sional purposes. The uses of mathematics for the study of other subjects may be found by analyzing the mathematical operations used in the solution of the problems contained in the textbooks for those subjects. The uses of mathematics for reading may be discovered by making a count and an analysis of the mathematical content in popular and scientific reading matter. The professional uses of mathematics may be discovered by making a job analysis of the mathematical requirements of the jobs of different professions, but this is beyond our present purpose. One of the first scientific studies of the uses of mathematics in the study of other subjects was made by Rugg and Clark,[8] who, in coöperation with Marjorie Miller analyzed the mathematical operations used to solve the problems contained in the most widely used textbook in first-year algebra, plane geometry, solid geometry, commercial arithmetic, physics, chemistry, general science, and physiography. The frequent operations for plane geometry, solid geometry, physics, and chemistry were as follows:

Plane geometry:

Evaluation
Multiplication
Division
Equations of the first degree, one unknown
Exponents
Radicals

Solid geometry:

Same as for plane geometry.

Physics:

Evaluation
Multiplication
Division
Equations of the first degree, one unknown

[8] Rugg, H. O. and Clark, John R., *Scientific Method in the Reconstruction of Ninth-Grade Mathematics.* Chicago: University of Chicago, School of Education, 1917.

Chemistry:

Evaluation
Multiplication
Division
Ratio and proportion

Besides the above there are a number which are "used to a noticeable extent."

The National Committee on Mathematical Requirements investigated the amount of mathematics that students need to know in order to take the elementary courses in college. They sent a questionnaire to professors of physics, chemistry, astronomy, history, economics, sociology, and political science. Replies were received from about 40 professors in the physical sciences and from about 20 in the social sciences. The topics below, stated in their order of importance, are the ones which 50 percent or more of the professors in the physical sciences marked as "essential."

1. Linear equations in one unknown
2. Simple formulas, their meaning and use
3. Ratio and proportion
4. Negative numbers, their meaning and use
5. Quadratic equations in one unknown
6. The linear function, $y = mx + b$
7. Simultaneous equations in two unknowns
8. Numerical trigonometry, the use of the sine, cosine and tangent in the solution of right triangles
9. Demonstrative geometry
10. Use of logarithms in computation
11. Graphs as a method of representing dependence
12. Numerical computation with approximate data
13. The quadratic function, $y = ax^2 + bx + c$
14. Plane trigonometry (usual course)
15. Graphic representation of statistical data
16. Statistics, meaning and use of elementary concepts
17. Variation

The meaning and use of elementary concepts in statistics was the only topic considered essential by as many as

50 percent of the professors of social science, although there were a number of other topics which they, as well as teachers of the physical sciences, rated as having "considerable value." Some of the above topics are too general for the ratings to have any value. Such are "demonstrative geometry" and "plane trigonometry (usual course)." These topics include many parts. It is possible that a judge will rate an entire course as essential because only a dozen theorems out of 100 or more are really important.

Thorndike[9] investigated the uses of mathematics for the study of other subjects by counting the number of uses of algebra per 100 linear inches of print in 44 textbooks on the social, physical, and biological sciences and on the practical arts; by securing ratings from each of 1[illegible] college professors on the value of each of 56 formal algebraic problems; and by securing ratings from each of ten college professors on the value of each of 19 verbal problems in algebra. After analyzing his data, he concluded that the chief use of algebra is in the reading of statistical graphs; that for physics, the principal value is in the mastery of the formula, particularly in being able to change the subject of the formula and solve the resulting equations, which are often in the form of fractions and may require the extraction of the numerical square root; and that for the solution of problems in chemistry, the ability to form a correct proportion and to solve mixture problems are important.

The uses of algebra in scientific reading were investigated by Thorndike by collecting and analyzing the mathematical references contained in the first 200 pages of each volume of the Encyclopedia Britannica from I to

[9] Thorndike, E. L., *The Psychology of Algebra.* New York: The Macmillan Company, 1926.

XXVIII. Out of 106,400 linear inches examined he found 19,741 that referred to mathematical usage. Of these, 22 were devoted to mathematical definitions, 7,781 required a knowledge of geometric shapes, 498 required algebra only, and 7,063 required more than elementary algebra. He concluded that the statistical graph and the formula have the widest use in reading matter; that from three to five years of mathematics beyond elementary algebra is necessary to read the articles dealing with the technical topics in physics, engineering, astronomy, mathematics, and allied subjects; and that the importance of mathematics in understanding subjects of general interest is much greater than indicated by the frequency of its use.

A careful analysis of the mathematics needed for the study of physics was made by Regan,[10] who solved and analyzed all the problems occurring in Millikan and Gale's *A First Course in Physics*. In arithmetic the requirements were knowledge of the four fundamental operations, knowledge of how to reduce a fraction, how to change a common fraction to a decimal, how to add a fraction as difficult as $1/110 + 1/220$, linear measure, time measure, percentage, and problems in measuration. In algebra the requirements were ability to translate a formula into words, to solve formulas for one unknown, to solve a linear equation for one unknown, and to add and multiply with signed numbers.

In geometry, a knowledge of the following facts was needed:

1. A right-angled parallelogram is a rectangle.
2. The opposite sides of a parallelogram are equal.
3. Two angles are equal if their sides are parallel, right side to right side and left side to left side.

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[10] Regan, G. W., "Mathematics Involved in Solving High-school Physics," *School Science and Mathematics*, Vol. XXV (1925), pp. 292–299.

4. Two right triangles are similar if an acute angle of one equals an acute angle of the other.

5. Corresponding sides of similar triangles are proportional.

6. The areas of two circles are to each other as the squares of their diameters.

7. Two lines in the same plane perpendicular to a third line are parallel.

8. If a line is drawn through to the side of a triangle parallel to the third side, the triangle formed is similar to the given triangle.

9. A right angle contains 90°.

10. The sum of the angles of a triangle equal 180°.

11. The acute angles of a right triangle are complementary.

12. The base angles of an isosceles trapezoid are equal.

13. Lines forming a right angle are perpendicular.

14. If the opposite sides of a quadrilateral are parallel, the figure is a parallelogram.

15. Two triangles are congruent if two angles and the included side of one equal respectively the two angles and included side of the other.

This analysis has the disadvantage of being based on only one book, which, however, is more quantitative than the average book of its kind; but it has the advantage of showing clearly how simple the mathematical requirements are in a high-school course in physics.

Instead of asking what the least amount of mathematics is that one must know in order to study certain subjects, we may inquire how much could one use if he knew how to use it? An investigation from this standpoint was made into the mathematical needs for the study of elementary-college courses offered at the University of Chicago. Georges [11] held conferences with members of the various science and social-science departments in the university. His principal finding from these conferences was that, with the exception of physics, no mathematics was required for the comprehension of the introductory courses. It was needed through calculus, however, for

[11] Georges, J. S., "Mathematics in the Scheme of General Education," *School Science and Mathematics*, Vol. XXXI (1932), pp. 57–65.

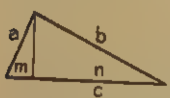
work of graduate level in all departments except psychology. Georges then undertook an analysis of textbooks in introductory college courses for the purpose of finding out what the author of the textbook could have used to develop his topic to advantage. This investigation provided a long list of topics including about everything taught in college algebra and trigonometry; the more difficult topics were irrationals, probability, projections, progressions, combinations and permutations, and binomial theorems. Calculus was not mentioned.

Summarizing the minimum mathematical needs of students for the reading and study of other subjects, we may say that in arithmetic these requisites are the fundamental operations with integers, decimals, and fractions; percentage, denominate numbers, mensuration, and square root. In algebra they are the statistical graph, elementary statistical constants, fundamental operations with signed numbers and monomials, the formula with one unknown, changing the subject of a formula, linear equations with one unknown, fractional equations, and proportion. In geometry they are the principal theorems dealing with triangles, quadrilaterals, and circles. These are minimum requirements, but we do not mean to say that much more cannot be profitably used. If the analysis made by Georges of the mathematics needed in the scheme of a general education is followed, it appears that the three years of mathematics usually offered in high school covers most of the requirements. We may say then, that the usual two-year course in mathematics is more than adequate for the minimum needs, but it is insufficient for the needs of a general education, as we usually think of the latter.

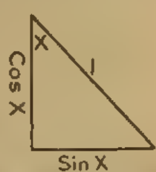
General mathematics for Grade IX. An economical way to meet the minimum needs of a secondary education

is to offer a course in general mathematics for Grade IX. Textbooks in this branch of secondary-school mathematics have been before the American public for about fifteen years but the courses so far have not proved to be very popular. A number of arguments are advanced in favor of this practice. Some of them are as follows: [12] It makes it possible to meet the minimum needs of a secondary education in one course, which may be taken by much larger numbers than when this work is given in several courses. It favors a psychological arrangement of subject matter, as the easier and more useful parts of each branch of mathematics may be brought together. It reduces the formation of separate courses and makes the presentation more interesting since there is much emphasis on application. It satisfies the demand for the concrete. For example, $a + b + c = 180$ may represent the sum of the angles of a triangle; $a^2 + b^2 = c^2$ may represent the relations between the sides of a right triangle; and the relation of algebra to geometry may be shown in the algebraic proof of the Pythagorean proposition as in the following illustration:

$m/a = a/c$, $n/b = b/c$; $a^2 = mc$, $b^2 = nc$, therefore $a^2 + b^2 = (m + n)\ c$, or c^2.



The knowledge of algebra and geometry may also be related to trigonometry. For example, the right triangle shown at the right may be used to make clear such relations as $\sin^2 x + \cos^2 x = 1$, $\tan x = \sin x/\cos x$, $\sec x = 1/\cos x$, and $\operatorname{cosec} x = 1/\sin x$.



Because these facts are made more comprehensible when presented together, with their relations to each other pointed out,

[12] Breslich, E. R., "Correlation of mathematical subjects," *School Science and Mathematics*, Vol. XX (1920), pp. 125–134.

the motivation for general mathematics is easier and the latter may be more profitably studied by many of the large numbers of students now coming to the secondary schools. A practical mastery of the reduced topics offered for minimum needs may be expected, although this is not now achieved in the separate courses. The mastery of a few things is likely to be more helpful to the pupil than the wide study of many things which are not mastered. For those who are able, the benefits of the extended curriculum may be derived from later courses. The chief arguments against general mathematics are the forces of habit which have been established in connection with the separate courses in mathematics, and the confusion to the pupil resulting from the changed methods of teaching; but these are transitory in character.

The value of generalized mathematics in junior high school, compared with the usual courses in arithmetic in Grades VII and VIII, was investigated by Stokes[13] at the University of Minnesota High School. He collected the data from pupils of Grade IX over a period of three years. The data consisted of scores in an achievement test for general mathematics for Grade IX, scores in achievement tests given at the beginning of Grade IX, such as the Woody Fundamentals Test in arithmetic; the Buckingham Problem Solving scale, an Inventory Scale, and scores in five standardized intelligence tests. There were 66 pupils who had taken arithmetic in Grades VII and VIII and 128 pupils who had had general mathematics in these grades. The former constituted Group I in the investigation while the latter constituted Group II.

The difference in favor of the group which had had

[13] Stokes, C. N., "Comparing the Effect of Arithmetic and General Mathematics in the Seventh and Eighth Grades upon Achievement in Ninth-Grade General Mathematics," *School Science and Mathematics*, Vol. XXX (1930), pp. 853–857.

general mathematics was more than twice as large as necessary to establish complete reliability. We may then be sure that general mathematics in Grades VII and VIII provided a better preparation for the general mathematics taught in Grade IX in this school than did arithmetic. We should notice, however, that the group which had had the usual arithmetic made a much better showing in the fundamentals than did the group in general mathematics. These results justify further experiments with general mathematics.

Is the quality of the material appropriate to the learner? The question whether the quality of the mathematics curriculum is such that it can be readily learned may be considered from various points of view, namely: the standards of achievement now attained, the changes that have been made in the curriculum, the special difficulties in the material, and the characteristics of interesting and useful material. We have already presented the standards of accuracy attained by college freshmen. If we judge the quality by these results, the only answer would be that it is very unsatisfactory; but as pointed out above, the causes of these results are many, and quality of material may not be one of them. If we judge the quality of the material by the amount of change which has occurred in the topics during the last hundred years, the indication is that the quality is very satisfactory. The amount of change which has occurred in the first-year course in algebra was made the problem of a special investigation by Chateauneuf.[14] She examined the textbooks during each decade from 1820 to 1920, analyzing the topics and calculating the average percent of space devoted to each topic during each decade.

[14] Chateauneuf, Amy A., *Changes in the Content of Elementary Algebra Since the Beginning of the High School Movement as Revealed by Textbooks of the Period.*

The most remarkable fact in the results was the small amount of change. Only one new topic, that of graphs, has been added. Even a hundred years ago the equation was considered the central topic in algebra. Besides the addition of graphs, the most important changes have been the reduction in space devoted to radicals and fractions and the increase in space devoted to formulas and factoring. It is debatable whether the great increase in factoring is an improvement. Since 1920 the amount of space given to this topic has been much reduced in some texts.

A similar study is not available to show the changes which have occurred in geometry during the last hundred years. Some idea may be obtained, however, from the comparison of two textbooks, one published in 1872 and the other in 1927. The one published in 1872 contains two parts: Part I, an introduction of 60 pages; and Part II, plane and solid geometry, 183 pages. Part I is devoted to definitions, which are "given once for all"; terms, and some theorems. All the definitions are illustrated, and for some there are constructions to be done. The theorems are not proved but shown to be true by measurement. It gives most of the facts of plane geometry and builds up a vocabulary. A total of 122 terms and theorems are given. Part II is demonstrative geometry and contains a total of 500 theorems, corollaries, scholia, and definitions. The work of each section is summarized by a brief logical outline. A total of 272 exercises is given by which the student may apply the theorems and corollaries.

The book published in 1927 is devoted entirely to plane geometry and contains 399 pages, as against 239 in the old book, but only 442 theorems and terms, as against 622 in the old book. The introduction, which consists also of definitions, illustrations and exercises in drawings, is limited to 21 pages. The remaining definitions are scat-

tered throughout the book and given as needed. There is an immense number of oral and written exercises, totalling about 1,275. Many of these show the applications of geometrical principles. Quite a few pictures are given to show the uses of geometry. At the end of the book there are sets of objective tests, a list of technical terms, a dictionary of geometrical terms, and a brief history of the science. The order of the theorems is also very different in the new book, with considerable attention given to putting the easier ones first. The principal changes in the new book are pedagogical: more interesting presentation, easier order of theorems, better arrangement of proofs, a reduction of 24 percent in the number of important facts, and emphasis on the uses of geometry and on habit-forming activities—all of which make the subject much more learnable.

Technical terms in algebra and geometry. A matter of more than usual importance in making mathematics more learnable is a reduction in the number of technical terms, together with the picking out and defining of the essential ones. It will be recalled that mathematical terms and symbols cause far more difficulties in reading mathematics than does any other phase of the subject. To reduce these difficulties investigations of the technical terms in algebra have been made by Thorndike [15] and by Pressey, Pressey and Narragon; [16] of those in geometry, by Brightbill [17] and by Pressey, Pressey and Zook.[18] The method of investigation may be illustrated from the procedure used by

[15] *Op. cit.*

[16] Pressey, S. L., Pressey, L. C., and Narragon, F. R., "Essential Vocabulary in Algebra," *School Science and Mathematics*, Vol. XXXII (1932), pp. 672–674.

[17] Brightbill, David F., *An Analysis of the Vocabulary Involved in Plane Geometry*. Master's thesis, University of Pittsburgh, 1928.

[18] Pressey, S. L., Pressey, Luella C., and Zook, R. C., "The Essential Technical Vocabulary of Plane Geometry," *School Science and Mathematics*, Vol. XXXII (1932), pp. 487–490.

Pressey, Pressey and Zook. The first step was to make a frequency count of the technical words in three standard texts. The second step was to have each of these words rated for importance by each of 38 teachers of geometry. The third step was to eliminate those not peculiar to geometry. The final step was to reduce the number of technical terms from 943 to 77. A similar procedure reduced the number of essential words in algebra from 382 to 52.

The essential words found in these investigations in algebra and geometry are given below. A thorough acquaintance with these terms should eliminate many of the difficulties incidental to the vocabulary of these subjects.

(Algebra)

Algebraic

Numbers	Coefficient	Binomial
Symbol	Positive	Polynomial
Terms	Negative	Algebraic
Quantity	Monomial	Consecutive

Factoring

Factoring	Factorable	Expand
Factor	Prime factor	

Graphs

X-axis	Graph	Linear
Y-axis	Plot	

Aggregation

Parenthesis		Brackets

Proportion

Proportion		Ratio

Fractions

Fractions	Denominator	Cancel
Numerator	Reduce	Invert

Powers and Roots

Power	Radical	Cube
Exponent	Extract	Ascending
Root	Square	Descending

Equations

Equation
Degree
Quadratic equation
Independent
Clearing of fractions
Transpose
Eliminate
Formula
Evaluate
Unknown
Simple equation (equation simultaneous)

(Geometry)

Section I: *Angles and Triangles*

Angle
Acute angle
Obtuse angle
Straight angle
Bisect
Equal
Supplementary
Degree
Right angle
Corresponding angle
Bisector
Common angle
Adjacent
Opposite angle
Triangle
Included angle
Equilateral triangle
Right triangle
Equiangular triangle
Hypotenuse
Base
Congruent
Altitude
Vertex
Vertices
Similar
External angle

Section II: *Straight Lines*

Perpendicular
Parallel
Transversal
Intersect
Equidistant
Midpoint
Locus
Ratio
Proportion

Section III: *Polygons*

Rectangle
Circle
Parallelogram
Square
Rhombus
Hexagon
Trapezoid
Quadrilateral
Diagonal
Perimeter
Polygon
Regular polygon
Equivalent
Area
Symmetry

Section IV: *Circles*

Arc
Center
Chord
Circumscribe
Diameter
Inscribe
Radius
Radii
Tangent
Secant
Circumference
Pi

Section V: *Terms Used in Presenting Theorems*

Axiom
Construction
Theorem
Proposition
Corollary
Plane
Surface
Geometric
Respectively
Proof
Given
Prove

It is possible that the learning of mathematics can be motivated by the selection of interesting and useful material. To find this material for algebra was made the object of a special investigation by Powell,[19] who collected 3,000 problems in algebra and had them rated on a scale of 10 by 500 teachers of algebra for genuineness, importance, and interest. He also investigated the reactions of students to these problems. He found that of the problems that had an average rating of 8 or more, 50 percent related to an economic situation, and of those that had a rating of 5 or more, 30 percent related to an economic situation. The remaining problems with a rating of 8 or above referred to averages, indirect measurement, levers, mixtures, and rate and work. All problems referring to age, angle measure, digits, clocks, and puzzles were rated at about zero in importance. The fact that most of the important problems were economic indicates a correlation between importance of content and the common experience of the majority of citizens. With respect to interest, Powell found that the teacher's judgment of interest was no index of what was interesting to the student, and also that the genuineness or importance of a problem had little to do with its interest for students. On the other hand problems were interesting if they expressed the activities of youth, expressed adult activities in the form of a race, referred to an economic situation in which an immediate gain was to be obtained by someone, or presented a definite challenge, for example, a puzzle stated as such. From the standpoint of motivation the most important findings were the characteristics of interesting problems and the fact that neither the judgment of teachers nor the genuineness of a problem was an index of interest for the pupil. From the

[19] Powell, Jesse J., *A Study of Problem Material in High-School Algebra.* New York: Teachers College, Columbia University, 1929.

standpoint of the curriculum Powell found the 500 best problems for first-year algebra out of a collection of 3,000, and a list of 61 formulas which had been given a rating of 5 or above by his judges. Teachers and writers of textbooks looking for good content will find this an important source.

Summarizing our discussion of the question of whether the content in mathematics is such as to be easily learned, we can say that the measurements made on college freshmen show that it is not well learned; that, as judged by the few changes made in the content during the last century, it appears to be fairly satisfactory; that, as the content is presented in current textbooks, it can be more easily and better learned than it was a half century ago; and that the learnability can be greatly increased by selecting interesting content, reducing the number of technical terms, and by selecting and defining those which are essential.

The quantity of content and criteria for selecting. The most important facts bearing on the question of whether the quantity of the content is such as to be readily mastered are the present lack of mastery shown in high-school graduates and the great amount of material offered beyond minimum needs. One way to reach higher degrees of accuracy would be to reduce the usual content by two thirds, as was done in spelling, then work toward mastery of the remainder; but a better way might be to center the content of the mathematics for Grade IX on the minimum needs in arithmetic, algebra, geometry, and trigonometry, making the chief goal a thorough understanding of each topic. The more advanced work could be offered for Grades X and XI, in which more emphasis could be given to appreciation.

But how shall we find the minimum needs? We have

already stated as our criterion social utility in the broad sense. This means mastery of enough mathematics to meet the requirements of life situations, as determined by frequency of use, and to fulfill the mathematical requirements of the reading and study of other high-school subjects and the mathematical requirements of such elementary courses in junior college as are thought necessary for the completion of a general education. Among the latter we would be willing to include the prerequisites of college algebra but not in the usual sense of two units of mathematics in high school.

Summary

The teaching of mathematics may be motivated by appeals to mastery or social motives, by providing interesting activity, and by selecting content which meets both the requirements of learning and the needs of individuals. Experiments in teaching arithmetic have proved the value of most of these forms of motivation.

One of the most effective forms of motivation is that supplied by the use of tests.

Teachers' marks have too much variability to give reliable information about a pupil's progress.

Standardized tests are good for measuring improvement over a long period of time but cannot be given frequently enough to guide instruction from day to day. For this purpose the new-type objective tests are much better.

The principal requirements of learning material from the standpoint of motivation are that it should make the principal motives easily realizable, that it should meet the needs of the pupil, that it should be of such quality that it is easily learned, and that it should be in such quantity that it can be mastered.

The objectives of developing an insight into the en-

vironment and an appreciation of what mathematics has done for the growth of civilization are widely ignored. The content is designed for the mastery of particular processes. This should give practical control, but the achievement of high-school graduates is far below anything that can be said to represent a mastery of the fundamentals. Practical control is not achieved. However, the content seems adequate to make this possible.

If the needs of pupils in mathematics are determined by what is needed for reading and studying nonmathematical high-school subjects and such elementary courses in a junior college as are thought to be necessary for meeting the requirements of a general education, we can say that the curriculum is more than sufficient for meeting these minimum needs.

Analytic studies show that the minimum needs in arithmetic are the fundamental operations with integers, decimals, and fractions; percentage; denominate numbers; mensuration; and square root. In algebra they are the statistical graph, elementary statistical constants, evaluation of the formula for one unknown, linear equations with one unknown, fractional equations, and proportion. In geometry, they are the principal theorems dealing with triangles, quadrilaterals, and circles.

If the needs are determined from the point of view of what the student could use in the subject studied in general education, if he knew how to use it, then the list of useful facts becomes much longer. From this point of view, two years of high-school mathematics are insufficient, but three years of it cover most of the needs.

An economical way to meet the minimum needs is through a course in general mathematics in Grade IX. Such a course should include a thorough review of the fundamentals of arithmetic, as well as the useful parts of

algebra, geometry, and trigonometry. There should be far more emphasis on mastery than at present.

General mathematics in Grades VII and VIII is a better preparation for general mathematics in Grade IX than is the study of arithmetic. It has a number of other advantages.

If the quality of high-school mathematics is judged by obtained measures of mastery, it is very unsatisfactory; but quality is probably not responsible for this condition. If the quality is judged by the changes made in the last hundred years in the topics treated in secondary school mathematics, the quality must be very satisfactory, for the changes have been few. In algebra the topic of graphs is the only addition during this period. In geometry a number of theorems and terms have been left out. The most important changes have been in the manner of presentation. The new books are much more interesting; the order of topics is easier; there is more emphasis on the uses of mathematics; and there is much more emphasis on habit-forming activities—all of which make the subject more learnable.

The selection and definition of the essential technical terms in mathematics should make a great improvement in the reading of mathematics.

The selection of interesting content should also be a help. According to Powell, interesting problems express the activities of youth, refer to an economic situation that has an immediate gain for someone, present a definite challenge as in a puzzle, or refer to adult activities in the form of a race. Neither genuineness nor the teacher's judgment is an index of interesting problems for children.

The fundamentals of the content in mathematics as now offered are not mastered. The amount offered is much greater than necessary for minimum needs. The

mastery of a much reduced content for Grade IX seems advisable. If this is done, the fuller content should be given in Grades X and XI.

The criterion for selecting content for secondary-school mathematics should be social utility when it is determined not only by frequency of use but also by that which gives insight into and appreciation of our environment.

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CHAPTER 22

Science: Objectives and Organization

The aim of the study of science is to understand and learn the use of things which make up the environment. An understanding is reached when we know how an event or thing is due to a transformation of energy. The use of an event or thing is learned when its energy is controlled by man for realizing his purpose. The subjects selected for study will presumably be those which have the greatest importance for man and which can be understood and used by the learner, such as the principles relating to an individual's or a community's health, safety, comfort, curiosity, and freedom of action. The more important topics will be those having to do with hygiene, food, clothing, shelter, communication, transportation, plant and animal life, human behavior, and the weather.

The N. E. A. Committee of 1920

Concerning the specific aims there is much disagreement. In 1920 a committee appointed by the National Education Association published a bulletin on the *Reorganization of Science in Secondary Schools,*[1] which emphasized the general values of science for health, worthy home membership, choice of vocation, citizenship, the worthy use of leisure time, and ethical character. Among the specific values of the study of science, this committee emphasized the development of interests, habits, and abilities; the teaching of useful methods of solving prob-

[1] National Education Association, Commission on the Reorganization of Secondary Education, *Reorganization of Science in Secondary Schools.* Bureau of Education, Bulletin No. 26, 1920.

lems; stimulation of the pupil to purposeful activities; informational values leading to an intelligent understanding of the conditions, institutions, demands, and opportunities of modern life; and cultural and aesthetic values, among which are an appreciation of the inner connections of things and of the service of science to the life and civilization of our time.

The N. E. A. Committee of 1927

A report from a committee appointed by the Department of Superintendence of the National Education Association published in the Fourth Yearbook of the Association in 1927,[2] listed a total of 70 different educational aims, classified into the following groups: ethical, spiritual, aesthetic, intellectual, social, civic, economic, vital, avocational, vocational, and practical. They ranged all the way from moral uprightness and reverence for nature to ability to use the forces of nature for personal betterment. The next year another committee from the same organization reported on the aims of junior high-school science-teaching, collected from 169 sources. Stated in order of their frequency of mention, they were: aid in choice of vocation; health; understanding of one's environment; knowledge of life's activities; good citizenship; ethical character; worthy home membership; wise use of leisure time; skill in scientific method, habits, and ideals; development of interests, attitudes, and capacities; development of skills in using materials; training judgment; development of constructive imagination and taste; cultivation of perceptive faculties; preparation for other subjects, command of the fundamental processes; acquaintance with scientific terminology; encouragement

[2] National Education Association, Department of Superintendence. *Fourth Yearbook*, 1926. Chapter IV, "Elementary Science and Nature Study."

of inquiry; conservation of natural resources; and dependence of industry on science.

It is evident that these committees do not distinguish clearly between the aims of a complete education and those which belong in particular to the study of science. They express much faith in disciplinary values, and fail to distinguish between those that may be developed equally well by any subject and those which may belong only to the study of science. But if the study of science does the whole job of education, it is questionable whether any other subject has a place in the curriculum.

N. S. S. E. Committee of 1932

In 1932 a committee of specialists in the teaching of science appointed by the National Society for the Study of Education published a report on various problems in the teaching of science in the Thirty-First Yearbook of this society.[3] It proposed that the teaching of science be organized around large objectives in the form of the fundamental principles and generalizations of science. It accepted as the general aim, not only of science, but also of all education: "life enrichment through participation in a democratic social order." These principles, of which the committee stated 38, are to be taught through the specific content available and appropriate to the interests and capacities of the listener. The committee gave some illustrations of types of content, but it did not recommend how boys and girls are to be taught the uses of science. There will be no quarrel with the general aim of science-teaching and of education as stated by the committee, but the problem is to determine the enrichments that are to

[3] Powers, S. R., "The Plan of the Public Schools and the Program of Science Teaching," National Society for the Study of Education, *Thirty-First Yearbook*, Part I, pp. 1–13. Also "What Are Some of the Contributions of Science to Liberal Education?" *Ibid.* pp. 27–41.

be given by the generalizations of science and the method by which they are to be obtained from them.

Some Enrichments of Life Furnished by Science

Among the enrichments of life furnished by the study of science are: the concentration of production in large industries; the concentration of population in large cities; the housing of people in large buildings; the protection of the health of people in cities and in rural districts by sanitation and control of contagious diseases; the increase in the food supply brought about by improving the fertility of the soil, building irrigation districts, breeding plants and animals selectively, preserving food through canning and refrigeration, and destroying pests; increasing production of all kinds by changing from man labor to machine labor; the instantaneous transmission of communication over an entire continent; the transportation of passengers and products at rates varying from 30 to 300 miles an hour by motor car and airplane; the building of concrete highways and steel railways; extensive use of electrical energy for lighting, heating, cooling, refrigeration, communication, and power.

The extensive use of electrical energy is illustrated in daily life. The writer is writing this paragraph by the light of an electric bulb. A little while ago he ate a dinner which was cooked with electricity and gas. His dessert was cooled in an electric refrigerator. The linens used were washed and ironed by electrical machinery. The rug of the dining room was swept with an electrical sweeper. The floor was polished with an electrical waxer.

While it is possible for one to use these many forms of electrical energy without knowing much about them, it is the study of science that made these things possible, and enables one to understand them.

The study of science, in addition to giving one an understanding of the physical and mechanical environment, gives an understanding of the social and economic structure of industrial civilization. The development of science changed society from an agricultural to an industrial basis, and the world from an aggregation of small neighborhoods to a society of nations. Great cities, states, and empires are not only based on the developments of science but also require the constant work of thousands of scientists for their daily maintenance. Even the modern family cannot be understood without a knowledge of science. Because of the developments of science, it is no longer an independent economic unit, but is dependent upon industry and business for its daily bread. The bond within the family is no longer economic, but is now largely social and psychological; and the wife, instead of being in bondage to the husband, is a free and independent person.

The study of science creates or may create attitudes which are valuable in solving problems outside of science; for example, such habits as basing judgment on measured facts, suspending judgment until sufficient facts are accumulated to warrant a judgment, examining the facts against a proposed hypothesis as well as those in favor of it before drawing a conclusion, being willing to change one's mind when the facts warrant it, respect for the opposing views of other scientists, and open-mindedness about the possibility of changes in truths that now seem to be well established. If these attitudes could be carried over into moral, religious, political, economic, and legal problems, human suffering would be greatly reduced.

The principle of organization is applied to science-teaching in three ways: reading, presentation by an instructor, and performing experiments in a laboratory.

We shall discuss how each of these may be used to develop an understanding of science.

Suggestions from Social Science

The effective methods of reading science are essentially the same as those of reading social science. In discussing the latter we found that it was helpful to use advance questions, to make advance explanations, to use sentence-completion exercises, to find the relation between title and central thoughts, to find solutions to problems, to analyze selections with respect to the central themes, to paraphrase the substance of a selection, to analyze difficult words, to outline, to write summaries, to prepare questions on a selection, to take training in answering questions of certain types, to take training in outlining the essential thoughts of a selection, to do extensive reading directed by a skillful teacher, to study a selection in the following order: (1) read it, (2) evaluate the significant points, (3) outline them, (4) summarize them, (5) answer questions about them; to read a selection as a whole, then study by parts, and finally integrate the parts into a whole. If these procedures are effective in the study of social science, they should be effective in the study of natural science. We have some experiments to show that some of them have proved to be so.

Drills on Selections from Text

Experiments relating to the reading and study of science were made by Austin,[4] Blank,[5] Moore,[6] Persing,[7]

[4] Austin, Loretta, *The Effect of Drill in Silent Reading on Comprehension in Biology*. Master's thesis, Syracuse University, 1930.

[5] Blank, Kermit J., "Improving Reading in Biology," *School Science and Mathematics*, Vol. XXXII (1932), pp. 889–892.

[6] Moore, H. K., "The Use of Short-Answer Type Questions in Providing Study Helps for Those with Reading Difficulties in Science," *School Science and Mathematics*, Vol. XXXII (1932), pp. 401–404.

[7] Persing, Kimber M., "A Practice Study in Paragraph Summarizing

Curtis,[8] Beauchamp,[9] Cunningham,[10] Rice,[11] and others. Austin gave reading drills selected from a text in biology. They consisted of three parts and required ten minutes a day for thirty days. The first part contained an outline of the main points in a paragraph; the second part was a paragraph explaining these points; and the third part consisted of questions on the comprehension of the points. The following illustration will help to give a clear idea.

Topic I. The Frog
- (a) Nature of Food
- (b) Adaptations for the process
  1. Slimy tongue
  2. Teeth
- (c) Functions of tongue and teeth

Frogs feed upon insects, fish, and other frogs, and even birds have been found in their stomachs. Insects are caught by the aid of their slimy tongues, the tip of which can be drawn back again with insect adhering to it. The tiny teeth that are found in the upper jaw and the two large teeth in the roof of the mouth are useful only in preventing escape of prey from the mouth.

1. Of what does the food of the frog consist?
2. What organ of the frog is examined to determine its diet?
3. Name the organs used to catch insects.
4. Mention the substance which covers the tongue.
5. What structures are located along the upper jaw?
6. Name the structures found in the roof of the mouth.
7. How is the escape of prey prevented?

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in Chemistry," *School Science and Mathematics*, Vol. XXIV (1924), pp. 598–604.

[8] Curtis, Francis D., "Some Values Derived from Extensive Reading of General Science," *Contributions to Education*, No. 163. New York: Teachers College, Columbia University, 1924.

[9] Beauchamp, Wilbur L., "A Preliminary Experimental Study of Technique in the Mastery of Subject-Matter in Elementary Physical Science," *Supplementary Educational Monographs*, No. 24. Chicago: The University of Chicago, 1923, pp. 47–87.

[10] Cunningham, Harry A., "Types of Thought Questions in General Science Textbooks and Laboratory Manuals," *General Science Quarterly*, Vol. IX (1925), pp. 91–95.

[11] Rice, R. S., *Extensive Reading versus Intensive Textbook Study as a Means of Acquiring Knowledge of Scientific Facts.* Doctor's thesis, Pennsylvania State College, 1935.

The work for one drill period usually consisted of three sections of this type. High-school students should not need drills of this type, since reading for the understanding of facts should be taught in the grades. However, good results were obtained from this method of training. The composite scores from three tests—The Ruch-Crossman Biology test, a silent reading test, and an informal achievement test in biology—showed that the experimental group, which consisted of 19 students, increased its average score from 108.1 to 143.6, while the control group of the same size increased its score from 108.8 to 118.2. The excess gain by the experimental group was 5.26 times its standard error, which shows that it was significant and that these drills were very profitable for the students.

Various Procedures

Blank[12] used a variety of procedures for developing speed and comprehension in reading biology: employing study helps for picking out the main points from given assignments; making outlines to show the organization of an assignment; requiring the pupils low in comprehension to write summaries of the main thought in a special report; asking thought-provoking questions in class; giving frequent new-type tests; making topical indentations which stated the main thought in certain paragraphs; and assigning interesting supplementary reading in popular books and magazines dealing with natural history. These types of training were continued for four months, before and after which a reading test, selected from a textbook in biology, was given to each of the class's 143 pupils. Comprehension was measured by the percent of questions answered correctly, while speed was measured

[12] *Loc. cit.*

by the average number of words used per minute during a three-minute period. It was found that the median speed increased from 197.5 words to 236.8 words per minute, and that comprehension increased from 9.71 percent to 80.33 percent. Because of the variety of procedures and the absence of a control group, it is impossible to tell which procedures increase speed, which ones increase comprehension, and which ones were useless. But the total effect was good, which indicates that the different procedures should be evaluated separately.

Completion Tests

Moore [13] obtained good results with completion tests. His procedure was to assign a certain number of pages in a text on chemistry, have the students do a certain number of experiments on the principles explained in the text, then have them fill in completion statements on the main points in the assignment. The class which used this procedure made as much gain in a semester as was expected of it in a year.

Single-Sentence Summaries

Persing [14] found that exercises in writing single-sentence summaries of paragraphs in a chemistry text were helpful in increasing a student's comprehension. He concluded that the difference between the initial and final tests meant a very decided improvement in learning efficiency and that this improvement carried over to other types of subject material.

Extensive Reading

Curtis,[15] and also Rice,[16] showed that extensive reading increases the student's achievement in general science.

[13] *Loc. cit.*
[14] *Loc. cit.*
[15] *Loc. cit.*
[16] *Op. cit.*

Curtis selected two libraries of about 40 books each from 347 books on science, none of which were textbooks but each of which was thought to contribute something to the interests of the pupils. Inside the front cover was a card which frankly stated the nature of the book and gave some guides, with page references, to interesting passages. In one experiment Curtis met once a week for 12 weeks with groups of boys from Grade VIII. The purpose of the meeting was not to teach the facts of general science but to stimulate voluntary reading. After six meetings one half of the group, or about 22 boys, dropped the meetings and served as a control group. There were two other control groups—a class of 30 boys from Grade VII and a class in general science of 59 boys from Grade IX. At the end of the experimental period, the experimental group was about a year ahead of the eliminated group paired with it from Grade VIII, about a half year further ahead of the group from Grade VII than would be expected from an additional year's growth and experience in this group, and about nine months of uninstructed development nearer to the average of Grade IX than would be expected. A second experiment showed that girls from Grade IX who spent two days a week in their regular classes in general science and one day a week with Curtis to be stimulated for voluntary reading made, during these months, a half-year's gain over the control group, which had three meetings a week with their regular teacher. Curtis concluded that extensive reading adds to a student's achievement in general science whether or not it is a part of a course in that subject; that, if given proper encouragement, students will read a great deal of scientific literature for recreation; that extensive reading is a good way of providing for individual differences; and that it stimulates some pupils to proceed further with the

study of science in school. In view of the fact that other investigators have found definite values for both concentrated and extensive reading in literature and in social science, we should not draw the inference that extensive reading is to be preferred in all cases in the study of science. It gives breadth of information and comprehension, but concentrated reading is necessary for the understanding of specific points.

Directed Study

Beauchamp[17] found several procedures in directed study superior to semidirected study. Each of his procedures was tried out in connection with the Morrison plan of teaching general science. His experiment continued from October to April, and carried several units, each of which used a different procedure. There were two classes of 26 pupils each, mostly from Grade VIII. At the start, the semidirected class excelled the directed-study class in both rate of reading and in ability to interpret the reading. Its average age was about six months greater than that of the directed class, but its median intelligence was slightly lower. In the general procedure for each unit, from 30 to 90 minutes were spent in preparation or exploration, during which the teacher found out what the pupils already knew about the unit to be studied; from 20 to 40 minutes were spent in the presentation, during which the teacher gave an overview of the entire unit; from 10 to 20 days were spent on the assimilation period, during which the pupils studied the materials relating to the unit; after this came a written report or organization of the unit, followed by an oral report, for which the pupils prepared a series of talks on important phases of the unit. In each unit the instructor,

[17] *Loc. cit.*

the time spent in study, the amount of material, tests, and the scoring and presentation were kept constant. In the first unit both classes used the same methods of study and reached the same median achievement. In the second unit the directed-study class was required to pick out and write the central idea in each paragraph. In the third unit it was required to write a question which suggested the central idea in each paragraph. In the fourth unit it was required to outline the general plan of the unit, then group the important facts around this general plan. In the fifth unit the directed-study class was given the following definite plan for solving problem questions:

1. Analyze the problem by finding the part which furnishes the data for its solution.
2. Break up the problem into questions.
3. Recall any experiences or information you have concerning the problem.
4. On the basis of these ideas, formulate probable solution of the problem.
5. Test your solutions to determine which is the right one.
6. Answer the problem.

In the sixth unit the problem was to determine whether training in methods of study had any effect on the student's rate of reading.

It was found that the experimental group excelled the control group when the following procedures were used:

1. Picking out and writing the central thought of a paragraph.
2. Outlining the general plan of a unit, then grouping the important facts around this plan.
3. Following a definite plan for solving thought problems.

The training in writing a question for the central idea in each paragraph was helpful in acquiring a large number of ideas, but it did not increase the understanding of technical terms or of major relationships, or the application of principles to the solution of problems. The results

indicated that this method focused attention too much on detail. In regard to the rate of reading it was found that analytic study slowed down the rate of reading, but increased the student's comprehension of what he read.

It will be recalled that Meeker discovered that training in answering questions of different types increased the student's ability to answer such questions in social science. A similar experiment on the value of training in answering questions on science is not available. However, Cunningham[18] counted and classified the number and types of questions occurring in seven textbooks and three laboratory manuals on general science. The total number of questions in the textbooks ranged from 116 to 3,546 with an average of 973. In the manuals the range was from 208 to 1,918. The authors seemed to be unaware that there are different types of questions, and consequently suggested no techniques for answering them. Cunningham classified these questions into twenty-two different types and recommended that training be given in answering each type. The more important types of questions were those which involved observation, pure memory, analysis, selective recall on a given basis, statement of cause and effect, application of a principle to a new situation, decision for or against comparison of two things in general, giving illustrations, statement of relationships, comparison of two things on a single designated basis, explanation of the use or meaning of some statement, summary of a unit, classification, and reorganization of facts on a new basis. The next step should be to work out a technique for answering each type, and to make a controlled experiment on its value.

Although a great number of important experiments on reading have been made, those relating to scientific

[18] *Loc. cit.*

material are not so valuable. Enough has been done to show that there are a number of devices which can be used for improving the comprehension of scientific material; but so far the experiments are too limited; the importance of experimenting with only one procedure at a time and of using control groups has been ignored; and the rule of using strictly equivalent groups has not been observed. Under the circumstances the conclusions reached by the experiments must be held tentatively, in need of verification. Such procedures as defining difficult and technical words, making outlines, picking out main points, asking questions on main points, writing summaries, using completion statements, extensive versus intensive reading, following a definite procedure in solving problems in reading, and others should be the objects of experiment under controlled conditions when each is used as a single variable.

Summary

The aim of the study of science is to understand and learn the uses of the events and things which make up the environment.

In instructing secondary-school pupils, the values of science for health, worthy use of leisure time, and ethical character should be emphasized.

Committee reports on the objectives of the study of science fail to distinguish clearly between the objectives of education in general and those peculiar to the study of science.

Among the objectives peculiar to the study of science should be an understanding of those characteristics of modern civilization which have their origin in the development of science; for example, the uses of electrical energy and the control of bacteria.

Another important objective of the study of science is an understanding of its relationship to the social and economic structure of industrial civilization.

The development of scientific attitudes and habits is one important objective of the study of science.

Methods of learning science may be divided into three classes, namely: reading, laboratory instruction, and presentation by an instructor.

Methods which are effective in reading social science are also effective in reading natural science.

In Austin's experiment it was found that comprehension in reading science could be much increased: first, by presenting an outline of the main points of a selection; second, by reading the selection; and third, by answering specific questions on the selection.

In Blank's experiment the following procedures were found helpful for increasing both speed and comprehension: employing study helps for picking out the main points, making outlines to show the organization, writing summaries of the main points, asking thought-provoking questions, and giving frequent new-type tests.

In Moore's experiment filling in completion statements on main points, and in Persing's experiments writing one-sentence summaries of paragraphs were found helpful for increasing comprehension.

Curtis found that extensive reading increased comprehension in general science, but this should not mean the neglect of concentrated reading.

In Beauchamp's experiment the following procedures were found to be effective: picking out and writing the central thought of a paragraph, outlining the general plan of a unit and grouping the important facts around this plan, and following a definite plan for solving thought problems.

Questions in science fall into many classes. There is evidence for believing that specific training in answering each type would help to increase comprehension and achievement.

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CHAPTER 23

Science: Organization and Practice

In this chapter we wish to discuss the principle of organization as applied to the teaching of science insofar as it relates to methods of presentation, and the principle of practice insofar as it applies to the relative efficiency of forms of laboratory work.

Methods of Presentation

The methods of presenting the content of science may be grouped into non-laboratory methods, methods using both non-laboratory and laboratory procedures, and methods using various forms of laboratory procedure. The principal question is: which one of these is the most effective? It is also important, however, to consider the merits and defects of each one, and the situations in which one is more effective than another.

Non-laboratory Procedures

Science, insofar as it is a subject to be learned by reading and listening, may be presented as a literary subject without the use of a laboratory. When this is done it has the same varieties of presentation as any other literary subject: inductive or deductive procedure, daily recitations, unit assignments, lecture method, textbook method, developmental method, supervised study, and study-guide plan. In this section we wish to discuss experiments in teaching science by one or more of these methods. We shall discuss the method of daily recitations versus the unit plan; a comparison between the

lecture, textbook, and developmental methods; and the use of a study-guide procedure.

Inductive versus deductive presentation. Most textbooks are written for deductive presentation of subject matter. The principles are stated and explained and finally clarified by pointing out a few applications. The value of an inductive procedure, which develops principles from concrete cases, was tried in an experiment by Peters.[1] He used 4 teachers and 167 students over a period of two semesters, and covered every important division of physics. In the deductive procedure a definite number of pages was assigned each class period. Most of the class period was spent in discussing, first, principles, and second, the applications in the textbook. The principles were discussed in a question-and-answer fashion individually with the pupils, the teachers giving a summary after the pupils had finished. In the laboratory work experiments which exemplified the laws studied in class were chosen. These were written up in a formal manner. In the inductive procedure the class began with a discussion of practical applications, then studied the principles involved. For example, in the study of heat the discussion began by study of the refrigerator. These discussions were usually led by the pupils, although the teacher asked questions to bring out the fundamental principles of physics. The laboratory work also centered upon applications and their principles, for example, the study of the principle of the fireless cooker.

The effectiveness of the two methods was measured by means of informal objective tests given at the beginning and end of the experimental period. Two tests were used, one designed to measure knowledge of principles,

[1] Peters, Chester J., "An Evaluation of a Reorganization of the Present Case of Subject Matter of High School Physics," *School Science and Mathematics*, Vol. XXVIII (1927), pp. 172–182.

and the other to measure knowledge of their application. These tests showed greater gains from the inductive procedure. For example, in School I, the deductive class made scores of 46.3 and 51.8 on the tests on principles and applications, respectively, while the inductive class made corresponding scores of 63.8 and 70.9 out of a possible 100.

Peters concluded that, from the standpoint of high-school physics, it is better to begin with the applications and draw the fundamental principle than to learn the principle first and then its applications. Black[2] tried a similar experiment and found little difference between the two methods, although there was a slight advantage in favor of the deductive. He concluded that physics could be learned by either method. The inductive method has the advantage of developing principles out of a concrete background of experience, but in the deductive method, if this concrete experience is supplied after stating the principle, the end result may be the same.

Daily Recitations Versus the Unit Plan

Experiments on the value of the daily-recitation and the unit plan in presenting subject matter in science have been performed by Corbally,[3] Shuller,[4] Shelton,[5] Bruce,[6]

[2] Black, Oswald F., *The Development of Certain Concepts of Physics in High School Students.* Doctor's thesis, Columbia University, 1930. (Published by "Die Weste," Potchestroom, South Africa, and distributed by Seiler's Book Store, New York City)

[3] Corbally, John E., "A Comparison of Two Methods of Teaching One Problem in General Science," *School Review,* Vol. XXXVIII (1930), pp. 61–66.

[4] Shuller, Albert T., "The Ready-Made Drawings with Relation to Student Achievement," *School and Society,* Vol. XXXII (1930), pp. 371–374.

[5] Shelton, Arthur L., "An Experimental Study of the Daily Recitation versus the Unit Plan," *School Review,* Vol. XXXVIII (1930), pp. 694–699.

[6] Bruce, G. V., "An Attempt to Vitalize Chemistry Teaching in the High School through a Modified Form of the Unit-Assignment Technique," *Science Education,* Vol. XVI (1932), pp. 392–403.

Hurd,[7] and Douglass and Fields.[8] Corbally, Shuller, and Shelton experimented with topics in general science; Hurd experimented with topics in physics; and Bruce experimented with topics in chemistry. Typical of this group are the experiments of Hurd and of Bruce. Hurd conducted an experiment on the relative value of what he called the textbook and work-sheet plans of teaching physics. The textbook plan was the usual plan of daily assignments and recitations, while the work-sheet plan gave unit assignments, with a work-sheet used as a guide for a unit of work. In each of 14 high schools one or more classes were instructed in a topic by each of these plans for a period of three weeks. Two objective tests were given before and after the presentation of the topic. On the whole the results were in favor of the work-sheet plan, but in some cases the textbook-recitation plan was the better. Hurd concluded that experienced teachers may develop certain procedures which work better for them than a plan outlined by a work sheet, and that it is probably safer to consider work sheets as aids which will be useful if used wisely.

Bruce taught two classes in chemistry, each for a year. In the first class he used the plan of daily assignments and recitations; in the second, the unit plan. There were 30 pupils in each class, who were balanced in age, sex, intelligence, and scholarship. Informal objective tests were given at the end of the course and one year later. The results, when compared for learning and retention, showed that some sections of the test favored the plan

[7] Hurd, A. W., "The Textbook versus Work-Sheets in Instruction," *Educational Administration and Supervision*, Vol. XVII (1931), pp. 661–664.

[8] Douglass, Harl R., and Fields, Geo. S., "An Experimental Comparison of the Daily Assignment-Daily Recitation and a Unit Assignment in High-School Chemistry," *Science Education*, Vol. XX (1936), pp. 141–145.

of daily assignments and recitations, while others favored the unit plan. The conclusions which the experimenter drew were that the daily-assignment method favored the parts that called for factual memory; that the unit method favored practical application and appreciation, provision for individual differences, and retention; and that the two were equal in those parts which involved the mechanical application of a principle. On the whole the daily assignment method favored learning and the unit plan favored retention. From the aggregate of these experiments we may conclude that the unit plan is not inferior to the plan of daily recitations. Because of the opportunities that it offers for integrating the subject and for making it meaningful, it has very important advantages.

A comparison of the developmental, textbook, and lecture methods of presentation. These three forms were the subject of experiments by Hunter,[9] and by Klopp.[10] In the developmental method, as used by Hunter, the teacher introduced the lesson as a problem which was discussed jointly by pupils and teacher. Whenever possible the concrete experiences of the pupil were introduced and used to develop the topic by means of questions. The teacher bridged many gaps by telling, but for the most part, kept up a rapid fire of questions directed to all members of the class. In the lecture method the teacher presented the material of the textbook, showing charts or making drawings to take the place of the illustrations in the text. No discussion was permitted, the

[9] Hunter, George W., "An Experiment in the Use of Three Different Methods of Teaching in the Class Room," *School Science and Mathematics,* Vol. XXI (1921), pp. 870–890.

[10] Klopp, Wm. Josiah, *An Experimental Study to Determine the Relative Merits of Three Methods of Teaching General Science in the High School.* Doctor's thesis, University of Southern California, 1928.

pupils being expected to take notes. In the textbook method the pupils quietly studied their assignments for 20 to 30 minutes, with no questions given or answered. After each lesson the pupils were given a test which usually consisted of two memory questions and one problem question. Hunter concluded that for immediate retention and for the development of power, the developmental method stood first, the lecture method second, and the textbook method third. In the delayed-retention test, the order of the three methods was (1) lecture, (2) developmental, and (3) textbook. But the developmental method was still the best, considering both memory and power. From another experiment Hunter concluded that the value of a given method depended a great deal on the personal equation of the teachers.

A similar experiment was made by Klopp, who tried the same methods but used the term *telling demonstration* for what he said was essentially the same method which Hunter called *developmental*. But he also said that this method was similar to the demonstration method used by Knox. If so, it was something more than a discussion method and included demonstrations by the teacher with the use of apparatus. He used 22 second-semester classes in general science from Grade IX, and 16 teachers. The classes had an average enrollment of 30 pupils, an average age of 15.2 years and were divided into three groups. The subject matter consisted of three units: one in botany, one in physics, and one in zoölogy. Each unit was subdivided into three assignments, each occupying one week. The entire experiment lasted nine weeks, and each participating class had 27 assignments. The methods were rotated for each unit so that each class had one unit by each method. There were informal objective tests at the beginning and end of each assignment.

There were also retention tests for all groups three weeks after the completion of an assignment. The results were measured both by the amount of progress made between the initial and final tests and by the final scores alone.

The comparative efficiency of the methods depended upon the method of measurement and upon the nature of the subject matter. Also the three groups did not get the same relative ranks for the three methods. The rank of the methods in terms of progress made was (1) lecture, (2) demonstration, and (3) textbook. Klopp said that when comparisons were made by several measures the results showed that the subject matter of general science required more than merely a textbook, however good it might be, and that the average child, in order to make the best progress, must be directed in his study by the teacher through demonstrations combined with discussion. He also stated that the maximum of success in physics, as well as in botany, might be obtained by the textbook and lecture methods, and in zoölogy by the textbook and demonstration methods. In one case, when put to a vote by the pupils the telling-demonstration method received 215 votes, the lecture method 172 votes, and the textbook method 81 votes. The results in several ways give an advantage to the telling-demonstration or developmental method, but a great deal more experimentation is needed before definite conclusions can be drawn.

The study-guide procedure. The study-guide procedure is a method which has been applied to the study and learning of science in recent years. It is a method of presentation as well as a method of study. It may be applied to any subject, but so far as is known to the writer, the method has been used more in science than in other subjects. Its aim is to make the student capable of independent study and research, to train the student

how to think in a given subject rather than to acquire information about it, to give the student an idea of the kind of questions that are asked in a given subject and how to find the answers rather than merely to train him to master the facts about it. Two important characteristics of the method are diminishing guidance and the so-called *learning threads*. The plan of diminishing guidance calls for a considerable amount of help when the student starts a new subject, but after this a reduction in the amount of help as rapidly as possible until the student can get along without any. Learning threads refer to the constant questions that are asked about every topic in a given subject. For example, in zoölogy we want to know certain things about every specimen, such as: How is it classified? What is its structure? What is its habitat? What is its food? How does it reproduce? What is its economic value? and so forth. When a student knows what questions to ask and how to find the answers, he can take up one topic after another and secure a systematic knowledge about it. When he has reached this point he is capable of independent study, which is the end result desired. Just as there are certain questions asked about a biological specimen, so there are characteristic questions asked about every field of study—they are the learning threads which enable the pupil to transfer his technique of investigation from one topic to another. Experiments with the study-guide plan, as applied to the study of science, have been made by Predmore [11] in biology, and by Blank [12] and by Clemensen [13] in physics.

[11] Predmore, Donald R., *An Experiment in Supervised Instruction in Zoölogy*. Master's thesis, University of Pittsburgh, 1930.

[12] Blank, Irene, *An Experiment in Supervised Instruction in Physics*. Master's thesis, University of Pittsburgh, 1928.

[13] Clemensen, Jessie W., "Study Outlines in Physics," *Contributions to Education*, No. 553. New York: Teachers College, Columbia University, 1933. Also "Vitalizing High-School Science through the Learning Process," *Science Education*, Vol. XIX (1935), pp. 49–56.

Predmore used 150 students in his experiment, with 50 pupils in three control classes paired against 50 pupils in two experimental classes for one semester of 20 weeks. During the first 10 weeks of the experiment the instruction in all classes was the same and was of the supervised-study type. The first part of the period was used for recitation and the second part for study. During the second half of the semester the procedures in the two groups were different in certain respects and identical in others. They were identical in the following respects: organization of subject matter into units, one or more experiments on each unit, an objective test at the end of every two units, and a final objective test covering all the units. They were different in the following respects: use of study guide, use of recitation, and use of textbooks. The experimental classes used the study guide, three textbooks, and recitations based on learning threads. The control classes had daily page assignments, recitations on these, and used only one text and a few references.

Since the study guide was the important distinguishing feature it needs some explanation. The first problem in making it was to select the learning threads. After consulting a number of textbooks the following factors were selected for the study of each unit:

1. Classification
2. Distribution
3. Habitat
4. Characteristics
5. External structure
6. Protection
7. Locomotion
8. Sense organs
9. Food taking
10. Digestion
11. Circulation
12. Respiration
13. Excretion
14. Nervous system
15. Skeletal system
16. Muscular system
17. Reproduction
18. Life history
19. Allied animals
20. Adaptations
21. Economic importance
22. Behavior
23. Methods of control
24. Protection by man
25. Migration

These factors were the learning threads. To use them the pupils must be taught the meaning of each and shown how they are applied. This was done in connection with the leopard frog. The guide sheet explained, for example, that classification referred to the grouping of animals according to similar characteristics, and that the grouping began with the most general class and ended with the common name of the particular species, by the following steps: kingdom, division, phylum, class, order, family genus, species, and common name. It explained further that each group had some characteristics in common with other groups, and some which distinguished it from them. This classification was then illustrated for the leopard frog by giving the name for each group. In a similar manner each of the other learning threads was explained as needed. In making assignments for the experimental group the teacher selected certain ones from day to day. Not all of them were studied in each unit—only those considered the most important. The questions raised by their assignment were to be solved by reading the relevant material in three textbooks. After the reading the pupil organized the material in such a way as to form an intelligent solution to his problem. The final examination for this experiment showed a small difference in favor of the study-guide plan, but it was not large enough to establish its superiority conclusively.

The experiments made by Blank and by Clemensen in the use of the study-guide plan for the teaching of physics found significant differences illustrating its superiority. The application of this method to the teaching of physics may be illustrated by a description of Blank's experiment. She used two equivalent groups which met for 55 minutes five times a week for 15 weeks. Three units—heat, sound, and light—were studied during the period. Each class

used the same textbooks, class procedure, instruction, experiments, mathematical problems, outlines, and tests. The only factor of difference was the study guide, which was given to the experimental group.

The science study guide consisted of three parts: the first part explained the purpose and value of the guide; the second part explained the sort of materials studied in science, what science does with these materials, and how to study science; part three explained the learning threads in physics. Part two stated that the materials of science consisted of matter, ether, and energy; that science tries to discover, investigate, and explain phenomena; that it tells how man makes use of the facts, principles and explanations of phenomena; and that in the study of science we observe facts and consider the sources of a phenomenon, its nature, its structure and composition, its actions and reactions, its actions under varied conditions, its measurement, its relation to other phenomena, the theories for explaining it, and its usefulness.

Part three of the physics study guide had as its principal learning threads such topics as nature, sources, transmission, measurement, characteristics, relation to other phenomena, and economic importance. Under *nature* the student was directed to make both a physical and a theoretical analysis. Under *sources* he was to consider whether they were natural or artificial, and their economic importance. Under *transmission* he was to give illustrations, to consider the means used, to classify the phenomena, to apply a theory to the facts, and to study their economic importance. Under *measurement* the student was to study the unit of measurement, the establishment of standard tables, the instruments of measurement, their economic importance, and the methods of measurement.

Under *characteristics* the student was to summarize all the properties of a fact. Under *relations to other phenomena* the student was to relate the fact to solids, liquids, gasses, sound, light, heat, magnetism and electricity; establish numerical values about these relationships; search for conditions which alter them; and study their economic importance. Under *economic importance* the applications of the principles of physics were studied, and the whole subject was viewed in the light of its economic importance.

TABLE 32

COMPARISON OF EXPERIMENTAL AND CONTROL CLASSES IN THE USE OF A STUDY GUIDE IN PHYSICS

(From Blank, 1929)

Test	Average Mark		Difference	Sigma Diff.	Chances in 100 that diff. is greater than 0
	Experimental	Control			
Heat..:...	93.90	87.83	6.07	3.61	95
Sound.....	40.54	37.94	2.60	3.18	79
Light.....	60.72	48.83	11.89	4.78	99

After the study guide had been studied by the pupils, they began to apply it to the study of heat. This topic was divided into the following seven units or blocks: production of heat, transmission of heat, thermometry, measurement of heat, effect of heat on matter, and heat and work. A guide applying the learning threads was prepared for each unit. Nine weeks were devoted to heat, three weeks to sound, and three weeks to light. No outlines were made for the units on sound or light, as the learning threads given in the science study guide were considered sufficient for the purpose. After the completion of each topic standardized tests were given to both

the experimental and the control classes. The results are given in Table 32.

In this experiment the differences in favor of the study-guide plan are large enough to justify continued and further experimentation on its use. Its merit as a learning procedure is due to its capacity to fix the student's attention on the type of question that he is to ask rather than on particular items of information, to force him to use his own ingenuity in discovering a technique for finding the answer, and to give him a generalized idea both of type of question and of technique for finding the answers.

Lecture and Textbook Procedures Compared with Laboratory Procedures

Because lecture and textbook methods of teaching science are less expensive and more time-conserving than laboratory methods, it is important to investigate their relative values. Experiments for solving this problem were made both by Mayman [14] and by Wiley.[15] Mayman taught 31 lessons in physics by each of the three methods to 14 classes of boys in Grades VII and VIII. He concluded that, on the basis of attainment, the three methods ranked from best to poorest in the order: individual laboratory, lecture, and book; but that, from the standpoint of time required by the teacher, the ranking was just the reverse. This conclusion, however, is weakened by the facts that attainment was measured by essay tests and that the groups were not equated. Wiley tested this conclusion with an improved technique. He used three

[14] Mayman, Jacob E., *An Experimental Investigation of the Book Method, Lecture Method, and Experimental Method.* Doctor's thesis, New York University, 1912.

[15] Wiley, William H., "An Experimental Study of Methods in Teaching High School Chemistry," *Journal of Educational Psychology,* Vol. IX (1918), pp. 181–198.

equated groups and also the method of rotation. Unfortunately, however, there were only eight pupils in a group; the results were measured by essay tests; and the experiment lasted only three days. He concluded that the differences between the three methods were much smaller than had been thought, that the textbook method was superior for immediate learning, and that the laboratory method was superior for permanent learning. This would be an important finding if it could be substantiated by further experimentation, but until this is done we can value it only as a problem for further research.

Lecture Demonstration Compared with Individual Laboratory Work

By the lecture-demonstration method is meant the performance of experiments by the teacher with an explanation of them at the time. By the individual-laboratory method is meant the performance of experiments by the student according to directions given him in a manual, then learning their significant points by answering questions on the data. There is much interest in the comparative value of these two methods because the lecture demonstration is much cheaper and makes possible the teaching of science to much larger groups. It is also much quicker because the teacher is skilled in setting up and doing experiments. From the standpoint of learning the lecture-demonstration method is just as concrete as the individual-laboratory. The student is more likely to master the significant points because they are explicitly stated by the teacher; but it does not develop laboratory skill or the ability to carry on independent investigations. In these respects the individual-laboratory method has the advantage, although it is surprising how often the pupil fails to comprehend the significance of the experi-

ments done by this method. In many cases, he merely follows directions and has no knowledge of the meaning of the data he has obtained.

So far, sixteen or more experiments have been made in an effort to find the comparative value of the two methods. These differ widely in duration, number of subjects used, and in scientific value. The majority of these experiments show that the lecture-demonstration method is either superior or equal to the individual-laboratory method for giving scientific information; only a few find results in favor of the individual-laboratory method for this purpose. So far, there are none who have found that the lecture-demonstration method favors the development of laboratory skill or the ability to solve problems in science by laboratory procedures; but only a few experiments have tested the two methods from this point of view. It appears that the method used must be selected with reference to the purpose for which science is taught. If the purpose is to develop a knowledge and an appreciation of science, we would choose the lecture-demonstration method; but if the purpose is to develop scientists or original investigators in science, then some form of individual-laboratory procedure should be used. These general statements, however, need application, illustration, and justification by a more detailed description of a few typical experiments. We select Johnson's[16] for biology, Walter's[17] for physics, and Horton's[18] for chemistry.

[16] Johnson, Palmer O., "A Comparison of the Lecture-Demonstration, Group Laboratory Experimentation, and Individual Laboratory Experimentation Methods of Teaching High-School Biology," *Journal of Educational Research,* Vol. XVIII (1931), pp. 103–111.

[17] Walter, Charles H., *A Comparative Study of the Teacher-Demonstration and the Individual Laboratory Method in Physics.* Master's thesis, University of Chicago, 1929.

[18] Horton, Ralph E., "Measurable Outcomes of Individual Laboratory Work in High School Chemistry," *Contributions to Education,* No. 303. New York: Teachers College, Columbia University, 1928.

Johnson's experiment on high-school biology. Johnson sought to find the comparative value of the lecture demonstration, group-laboratory experimentation, and individual-laboratory experimentation for teaching high-school biology. Two separate experiments were made, each one occupying a semester. In the first semester three high-school classes of 11 pupils each were paired on the basis of an intelligence test. In the second semester three classes of about 17 pupils were used unpaired. Five double 40-minute periods were given to the subject each week. The rotation procedure was used in such a way that each class performed 8 laboratory exercises by each method during each semester.

In the lecture demonstration, the teacher performed an experiment according to the same directions that were given to the other two classes. The order of procedure was:

1. Statement of problem
2. Performance according to method prescribed
3. Making observations
4. Formulation of conclusions

In the group experimentation four or five students worked together and performed an experiment according to directions. In the individual experimentations each student worked alone, communicated with no one, made his own observations, and drew his own conclusions. The teacher supervised the work of the groups and of the individuals, and saw to it that the conditions prescribed were carried out. Informal objective tests were given at the completion of each unit, which sometimes consisted of only one laboratory exercise and sometimes of several. Retention tests were also given at different intervals. All scores were reduced to a percentage basis so they would be comparable. The result in each experi-

ment was in favor of the lecture demonstration, but not by a sufficient amount to make its superiority statistically significant. The author concluded that, under these conditions, the lecture demonstration might be said to be at least equal to if not better than the group- and individual-laboratory method, and that this fact becomes significant in view of the saving in laboratory equipment. No significant difference was found between the individual- and group-laboratory procedures. The standard deviations were found to be larger for the group which used the individual-laboratory method. The author interpreted this as showing that individual methods provide a better opportunity for the expression of individual differences. The more exact meaning of this, however, is that some individuals do very well by the individual method, but that others do very poorly. Consequently there is a wide range between the best and the poorest. The smaller standard deviation for the lecture-demonstration method means that the results get across to the pupil with more nearly equal effectiveness. The poor pupils are able to get the essential points as well as are the good ones. The writer therefore interprets the smaller standard deviation as a mark in favor of the lecture-demonstration method.

Walter's experiment in high-school physics. Walter used four classes of 30 pupils each in physics. Two of these classes used the individual-laboratory method, while two of them used the lecture-demonstration method. From these two groups 40 pupils were paired with each other in sex, intelligence, and previous achievement. The experiment was continued for one semester, but at a point within the semester the methods were reversed, the demonstration group changing to the individual method and the individual group changing to the demonstration method. Each group received the same amount of time.

The time saved by the demonstrations was used to give the pupils drill on essential points. The results were measured both by informal objective tests and by standardized tests. In the informal tests in immediate achievement the median score for the individual-laboratory group was 42.8, and for the lecture-demonstration group 47.0. The corresponding scores in the delayed test were 47.8 and 54.7, respectively. In the standardized tests the total score for the individual-laboratory group was 1207.9, while for the lecture-demonstration group it was 1281.6. According to either type of test the advantages are in favor of the demonstration method.

Walter also compared the ability of the two groups to attack a new experimental problem. The two groups were measured by the time required to do the task, the average amount of error made, the percent of error, and the knowledge of the method used.

The results showed the respect in which the individual-laboratory method yielded superior results, namely: in ability to manipulate apparatus. A skill of this kind can be formed only by practice, and the method which provides the most practice would be expected to yield the best results. But in understanding and knowledge—even in knowledge of experimental method—the lecture-demonstration method showed superior results, which Walter attributed to the effects of drill. From the experiments of others he made the observation that the individual-laboratory and lecture-demonstration methods were practically equal; but in these experiments the demonstration group used less time. Since in his experiment the time was the same for each group, and since the time saved by demonstrations was used for drill, he concluded that the superior results obtained by the demonstration-drill method were due to the use of drill.

This interpretation is undoubtedly correct. But the reversal of the methods and the use of drill introduces variables in the experimental procedure that make an exact evaluation of the several factors difficult. However, if there is no important difference between the two methods used, the saving in expense for the demonstration method is an important consideration.

Horton's experiments in chemistry. Horton's experiments in chemistry on the outcome of demonstration and laboratory procedures are the most extensive and accurate of any that have been done in this field to date. His results probably go farther than other experiments toward giving us solutions to the questions concerning the comparative values of laboratory procedures in the teaching of science. Three of his experiments are worth while describing at this point. These may be called the *two-group experiment,* the *rotation experiment,* and the *multiple-group experiment.*

The purpose of the two-group experiment was to compare the results obtained by the individual-laboratory method and the lecture-demonstration method in terms of written and performance tests. Seventeen beginning classes in chemistry in the Seward High School, New York City, were used in the experiment. Four of these, consisting of a total of 85 pupils, were taught by the demonstration method and were called the experimental group; the remaining thirteen classes, consisting of a total of 379 pupils, were taught by the individual-laboratory method and were called the control group. The two classes were assumed to be equal, but as a check on this assumption, the marks of the students in the Regents' Examination in biology given the year before were compared. The individual group averaged 78.92, while the demonstration group averaged 78.88—evidence that the

groups were about equal. All classes met five times a week for 50 minutes, with one period each week used for laboratory work. In the experimental classes the teachers demonstrated the experiment according to directions, while in the control classes each pupil performed the experiment alone according to written directions. All pupils in both groups wrote up the experiments in the same way under the headings: purpose, sketch, method, observations, and summary. The results were measured both by written examinations and by performance tests prepared by a committee of teachers and constructed in such a way that the items could be scored objectively according to a key. The written examinations were given both at the end and during the middle of the semester, while the performance tests were given only at the end of the semester.

According to each test the individual-laboratory method yielded superior results. The amount of superiority in the written examination was small and not quite enough to be statistically significant, but in the performance tests it was large and statistically significant. The practical meaning of this is that for purposes of giving information and training the pupil to think in terms of science the two methods are nearly equal, but for training the pupils to perform experiments the individual-laboratory method is superior.

The effect of the two methods on individual differences is worth noticing. In the written examination the individual-laboratory group had the larger S. D., while in the performance test the lecture-demonstration group had the larger S. D. This means that the lecture-demonstration method gets the instruction across to all members of the class with more nearly equal effectiveness than does the individual-laboratory method, but in regard

to skill in doing experiments just the reverse is true. It appears that there are a number who learn very little from an individual experiment done according to directions, and that there are also a number who acquire little laboratory skill from the observation of an experiment. In view of these results the effectiveness of each method must be judged from the purposes of the course.

The object of the rotation experiment was to determine the comparative value of the individual-laboratory and lecture-demonstration methods for giving pupils specific information in chemistry, for developing ability to think in the science, and for training them in ability to perform laboratory experiments in it. Two other groups, consisting of 18 and 25 pupils each and taught by the same teacher, were drawn from the experimental and control groups near the end of the semester. They were taught two special topics: the preparation of ammonia and of the oxides of nitrogen. The rotation of the instruction was such that each learned one of the topics by the individual-laboratory method and the other topic by the lecture-demonstration method. On the day before and the day after the presentation of each topic each class received a written test upon the topic taught. One week after the written test on the two topics each class received a performance test in the preparation and testing of oxide and ammonia. The operations for these tasks were previously worked out very carefully so that a monitor could score them easily. An index of efficiency for the performance was worked out; this considered the total time, the time for each operation, the number of items correct, and the number of errors. The results showed that in the written test for the two exercises Class *A*, which had been trained during the semester by the individual-laboratory method, made an average score of 17.15, while Class *B*, which had

been trained by the lecture-demonstration method, made an average score of 13.16, the ratio of the standard deviation of the difference to the difference (Difference divided by S. D. diff.) being 2.52, or .48 short of the amount necessary to insure that the difference is significant. In the performance test the average score for Class A was 52.57, while for Class B it was 32.00, the standard deviation of the difference being 6.45. The ratio of the obtained difference to its standard deviation was 3.18, which shows that this difference is significant.

The results of this experiment confirm those obtained in the two-group experiment, namely: that the lecture-demonstration method is nearly the equal of the individual-laboratory method for imparting information and for developing ability to think in science, but is inferior for training pupils to do the tasks which are done in the laboratory.

The purpose of the multiple-group experiment was to determine the relative value of four methods of doing laboratory work. These were as follows: C, doing individual-laboratory work according to written directions; D, doing experiments by the lecture-demonstration method; E, doing individual experiments by the problem method without any direction; and G, doing individual-laboratory work according to general directions and suggestions derived from the study of drawings of typical apparatus. There were also varieties of the D or demonstration method and of the E or problem method, designated as D_2 and E_2, respectively. In the D_2 method the class had the regular or C_1 instruction for the first ten weeks and the D_1 or the lecture-demonstration procedure for the second ten weeks. In the E_2 method the class had the regular or C_1 instruction for the first ten weeks and the E or problem method for the second ten weeks. In

all groups the laboratory period occurred once a week for 50 minutes for 20 weeks. There were regular recitations during the four days of each week. The results of the various procedures were measured by four kinds of tests, namely: (1) a written test covering the course, (2) a class-performance test of laboratory projects in which two new substances were prepared, (3) a performance test of ability to set up apparatus and to understand the purposes of the various pieces, and (4) an individual-performance test requiring the use of 55 basic operations.

In this experiment no reliable difference appeared between any of the procedures used when the results were measured by the written examination, but this was not the case when the results were measured by Test 4, the individual-performance test. The average of the 26 pupils who took some form of individual-laboratory work (Methods C_1, E_1, E_2, and G) was 26.58, and for the 12 lecture-demonstration pupils 19.75. The ratio of the difference to its S. D. was 4.32. These results again show that one laboratory procedure is about as good as another for giving training in knowledge of, and skill in thinking in chemistry; but they are unequal for developing ability to do the tasks in the laboratory. For these purposes, the rank of the four methods was as follows: first, the problem method, or doing individual-laboratory work without direction; second, doing individual-laboratory work according to generalizations from general directions; third, individual-laboratory work according to directions from a manual; and fourth, the lecture-demonstration method. Horton said that doing laboratory work according to directions contributed little to ability to work without directions and that, after a preliminary period, substitution of demonstration work for individual work was justifiable and possible, but that this method was not adequate for

developing independent ability to solve laboratory problems. It is then clear that before we can select the most effective and economical methods, we must determine our goals. If the goal is an understanding of science, we should select the lecture-demonstration method. If the goal is ability to do scientific problems in the laboratory, we should select some form of individual-laboratory work. Society must have both types of individuals: those who understand science and those who can solve scientific problems in the laboratory. But the latter group is comparatively small, and should be selected from the former group. From the standpoint of public education in the secondary schools, it would seem to be a good policy to have the first courses taught by the lecture-demonstration method, and to limit individual-laboratory work to those who give promise of doing successful advanced work.

Various Forms of Practice for Laboratory Work

The lecture-demonstration and individual methods of laboratory work may be carried on in various ways. The experiment may be written up in full or it may not be written up. It may be written in a conventional way or it may be written up by diagrams. It may have drawings in it, and if so the drawings may be done in ink or pencil. The experiment may also be done with varying amounts of help, as described in Horton's procedures. The laboratory periods may also be double or single. At this point, we wish to review the studies that relate to these questions.

How Much Help Should the Student Have in Laboratory Work?

We have already seen from Horton's work that individual-laboratory work without direction yields the best re-

sults. After this he found the value of other procedures to be in the following order: (1) individual work with general directions, and (2) lecture-demonstration work. Walter [19] obtained similar results in physics. He tried out what he called the *individual-manual method,* the *individual-no-manual method,* and the *demonstration method.* In the individual-manual method the student received the material and did the experiment according to the directions in the manual and under the direction of the teacher. In the individual-no-manual method the student was given the material, told to prove a certain law, and given some suggestions as to how to use the apparatus. In the demonstration method the teacher demonstrated the experiment according to the directions in the manual. The best results were obtained from the individual-no-manual method, the next best from the demonstration method, and the poorest from the individual-manual method. The reasons for the superiority resulting from doing work without directions are probably that the pupil must first understand the law which he is to prove, then think out his own techniques for proving it, and finally interpret his results in relation to his problem. When he follows a manual he simply thinks enough to follow directions, but usually fails to see the relation of each part to the main problem. It is clear, however, that a pupil cannot follow this method until he has an acquaintance with apparatus, knows how to put it together, and understands some of its uses. It seems then, that the teacher should start by giving complete directions to the pupil, and give decreasing help until it can be and is entirely omitted. How rapid the decrease should be must be determined by experience.

[19] Walter, Charles H., "The Individual Laboratory Method of Teaching Physics When No Printed Directions Are Used," *School Science and Mathematics,* Vol. XXV (1930), pp. 429–432.

Should an experiment be written up in full or is it sufficient for the student to take some notes on it? An answer to this question is furnished by an experiment done by Wilkinson,[20] who tried out the individual-laboratory and the lecture-demonstration methods in two forms. In one form the students wrote complete reports of the experiment, while in the other they merely took notes on the experiment either while it was being demonstrated or while they performed it. Four classes in physics having a total enrollment of 88 pupils were used. Each class did four experiments, which were rotated in such a way that one experiment was done by each method. Objective tests were given before, immediately after, and four months after, each experiment. The percent of gain between the first and second and between the first and third tests was calculated for each class. The sum of the gains by the four classes on each method gave a measure of its effectiveness. In the immediate tests the individual-laboratory method with a complete report yielded a score of 170.8; the lecture-demonstration method with a complete report a score of 154.65, the individual-laboratory method without a complete report a score of 132.6, and the lecture-demonstration method without a complete report a score of 125.1. The average of the two sets with complete report was 162.72, while that of the two sets without complete report was 128.6, a large difference in favor of the complete report. If learning is accomplished by doing and thinking, then the complete report should make such a difference. If a student writes out the purpose, the materials, the method, and the results and interpretation of an experiment, he should

[20] Wilkinson, Geo. H., *An Experimental Study of Four Methods of Laboratory Procedure in Teaching High-School Physics.* Master's thesis, University of Southern California, 1927.

know considerably more about it than if he merely observes.

How should an experiment be written up? The formal way to write up an experiment is to state the problem or purpose, name the materials, make drawings of the experimental set-up, describe the procedure, state the results, and interpret them or answer questions about them. This procedure, particularly the drawing of the experimental set-up and the description of the procedure, requires much writing; this part of the write-up is often copied from the manual and may not have much educational value. The value of substituting the diagram method for this part of the write-up was tried out in an experiment by Moor, Dykhouse, and Curtis.[21] In the diagram method a series of diagrams is given to show the successive stages in the experimental manipulation. Two sets of equivalent groups were used for fifteen weeks, one from Grade VIII and one from Grade IX. In Grade VIII one 45-minute period a week was given to laboratory work, and in Grade IX two such periods a week were given to laboratory work. The results showed small differences in favor of the diagram method, which also was about 10 percent shorter in time than the formal or conventional method. The experimenters suggested that the advantage of the diagram method could be considerably increased by using the time saved in useful drill.

Should all the students in the class do the same experiment at the same time or should they do the various experiments at different times? The first procedure is called the *even-front system* and the second is called the *rotation system*. The comparative value of these two sys-

[21] Moore, Fred W., Dykhouse, Claude J., and Curtis, Francis D., "A Study of the Relative Effectiveness of Two Methods of Reporting Laboratory Exercises in General Science," *Science Education*, Vol. XIII (1929), pp. 229–235.

tems is a matter of considerable importance in experiments requiring expensive equipment, such as those in physics. It is not so important in biology or chemistry, where the material used is not so costly. An important advantage of the even-front system is that it makes it possible to keep the laboratory and the class work rather close together, although this often is not possible when laboratory work can be done only on certain days and periods. If this advantage is lost the time of the experiment has little importance. The comparative value of the even-front and rotation systems was the problem in an experiment in the teaching of physics by Duel,[22] who used two equivalent groups on the subjects of magnetism and electricity. There were 18 laboratory exercises distributed over 10 weeks. Two series of such experiments were made. The results from informal objective and standardized tests showed small differences in favor of the rotation system, which also saved much time in the setting-up and care of the apparatus. The saving in expense by this method is an important factor, its amount depending on the number of duplicate sets saved by the rotation as against the even-front system.

Should the student make drawings in biology, and if so, should they be representative or analytical, and should they be done in pencil or in ink? The value of making laboratory drawings was investigated by Ballew,[23] by Taylor,[24] and by Alpern.[25] Ballew used two beginning

[22] Duel, H. W., "The Even-Front System versus the Rotation System in Laboratory Physics," *School Review*, Vol. XXXVI (1928), pp. 447–454.

[23] Ballew, Ainer M., "A Comparative Study of the Effectiveness of Laboratory Exercises in High School Zoology with and without Drawings," *School Review*, Vol. XXXVI (1929), pp. 284–295.

[24] Taylor, Laurene, "The Ready-Made Drawings with Relation to Student Achievement," *School and Society*, Vol. XXXII (1930), pp. 371–374.

[25] Alpern, Mavis L., "A Comparative Study of the Effectiveness of Student-Made and -Prepared Drawings in College Laboratory Work in Biology," *Science Education*, Vol. XX (1936), pp. 24–30.

classes in high-school zoölogy. Each class did 14 laboratory exercises over a period of five months, 7 with, and 7 without drawings. Each laboratory exercise consisted of two parts: Part I gave directions of what to do; how to make drawings, if any; and contained a list of 15 supplementary questions that called attention to important points. The student was to answer as many of these as time permitted after he completed his other work. Part II was an objective test based on the laboratory exercise and measured both memory and analysis. The drawings were representative in character; that is, were as exact copies as possible of all the features of the specimen. The principal difference in the two procedures was that the classes without drawings answered many more supplementary questions than the classes with drawings. The experimenter drew the conclusion that the construction of representative drawings did not aid pupils in making analytical observations, that it did not improve their memory of observations, and that it would be advisable to replace drawings with other work.

Taylor compared the value of making drawings with that of labeling ready-made drawings in an experiment with paired groups of 66 college students each. An objective test showed that the students who labeled ready-made drawings had an achievement from 8.8 to 14.1 percent better than those who made drawings. Alpern confirmed Taylor's work and concluded that the labeling of ready-made drawings was as effective as student-made drawings at all levels of ability.

Ayer [26] made a study of the comparative value of representative drawings and analytical drawings—those which reproduce the exact appearance of an object and those

[26] Ayer, Fred C., *The Psychology of Drawing with Special Reference to Laboratory Teaching*, pp. 37–39. Baltimore: Warwick & York, Inc., 1916.

which sketch important features—and concluded that representative drawings were a waste of time from the standpoint of interest in scientific thinking. Cooprider[27] compared pencil drawings and ink drawings for their educational value. He found that the students who inked their drawings were better in preparation, achievement, and retention than those who made pencil drawings. They were also superior in identifying plants and other structures, naming stages in the life history of plants, and in reconstructing from memory drawings of plants or organs and parts of organs. Cooprider thought that the extra time required to ink drawings was well spent and explained the superiority of inked drawings by the fact that dim, loose, and hastily drawn lines were usually avoided when ink was used. The conclusions from these experiments, then, are that it is ordinarily better not to make drawings at all but to spend the time in study; that if drawings must be made, it is better to make them analytical than representative, and to do them in ink rather than in pencil.

Should laboratory periods be single or double? An interesting experiment upon this problem was performed by Spitler[28] in four Kansas City high schools. One of these high schools had 2 two-hour laboratory periods a week, while the other had 2 one-hour periods in both physics and chemistry. Each high school had from 50 to 85 pupils in both chemistry and physics. North East High School, which used the double laboratory periods, had from 37 to 57 pupils who matched an equal or a larger number in intelligence in each of the other three high schools. The gains made by each group were meas-

[27] Cooprider, W. W., "Laboratory Methods in High School," *School Science and Mathematics*, Vol. XXIII (1923), pp. 526–530.
[28] Spitler, John L., *The Relative Value of Single and Double Periods in Physics and Chemistry*. Master's thesis, University of Kansas, 1927.

ured by average differences in the scores of standardized tests given at the beginning and end of a semester. For paired pupils the results showed that the average gains for the pupils taking the double laboratory periods in physics was 23.50, as against 19.91 and 24.94 in two other high schools having single periods. The students having double laboratory periods in chemistry made an average gain of 8.43, as against 5.86, 12.32, and 5.84 in three other high schools. These results have been confirmed in another investigation by Applegarth.[29] They show, at any rate, that the length of laboratory periods is not an important factor in determining the gains made in physics or chemistry as measured by standardized tests. Single laboratory periods appear to be as effective as double ones for imparting information. If there is any difference, it would probably appear in a performance test of laboratory skill, which unfortunately was not measured in this experiment.

The Use of Visual Aids in Teaching Science

Visual aids in the form of charts, drawings, models, and motion picture films are useful in the teaching of science. There are questions, however, about their relative values, the stage in the learning process at which they can be most profitably used, and the type of subject matter for which they are most effective. Theoretically it would seem that visual aids have their greatest usefulness in teaching structure and action, for it is very difficult to give a clear presentation of them through other sensory modes. If it is a question of learning a principle, forming a generalization, or understanding a theory, the visual is probably no better than any other form of presentation.

[29] Applegarth, T. W., "Comparison of the Effectiveness of the Single Laboratory Period in High School Chemistry," *School Science and Mathematics*, Vol. XXXV (1935), pp. 627–633.

A number of experiments have been made upon the comparative value of different visual aids and upon effective ways to use them. We shall refer to some of them.

In an experiment on the relative value of models, charts, and teacher's drawings for teaching plant structure Huebner[30] found that teacher's drawings and models were both more effective than charts and that teacher's drawings were somewhat superior to models. This would probably not be true of just any teacher's drawings, but only of those equal in quality to Miss Huebner's. Since models have a third dimension they can represent a structure far more accurately than a chart, but often it is a question whether the difference in effectiveness compensates for the difference in cost.

The comparative value of a lecture demonstration by a teacher and by a motion-picture film was tried out by Rolfe[31] in physics, and by Hollis[32] in cooking. In advance of experimentation, one might think the film to be superior because it is usually prepared with the best equipment, with the greatest care, and only after the processes have been well perfected by practice. The film also can be seen equally well by each of a large number of students. In spite of these apparent advantages much better results were obtained with the lecture demonstration by the teacher. Rolfe worked with four classes of 20 pupils each. In two classes the procedure was as follows: study static electricity for thirty minutes; look at two showings of film for 30 minutes, then take a test. In the

[30] Huebner, Dorthy E., "A Comparative Study of the Effectiveness of Models, Charts, and Teacher's Drawings in the Teaching of Plant Structures," *School Science and Mathematics*, Vol. XXIX (1929), pp. 65–70.

[31] Rolfe, S. L., "The Effectiveness of the Film and Demonstration in Teaching Physics," *Visual Education* (F. N. Freeman Edition), pp. 335–339. Chicago: Univ. of Chicago Press, 1924.

[32] Hollis, A. P., "The Effectiveness of the Film and Demonstration in Teaching Cooking," *ibid.*, pp. 339–342.

other two classes the procedure was the same except that the teacher gave a demonstration instead of showing the films. On the second day the students were given a performance test in the laboratory on the same experiments. In the written test the demonstration group made an average score of 85.3, as against an average of 65.8 by the motion-picture group. In the performance test the demonstration group made an average score of 85.9, as against an average of 69.7 by the motion-picture group.

In the experiment in cooking Hollis gave in three ways a lesson on how to make an omelet: telling, demonstration, and use of motion-picture films. The telling method usually yielded the poorest results, the film method the next best, and the demonstration method the best. According to both of these experiments demonstrations by the living teacher using apparatus are superior to those given by a motion-picture film.

An extensive experiment on the value of motion pictures in teaching general science was made by Wood and Freeman,[33] who discovered that those taught with the aid of films showed better results than those taught without this aid. They used 3,265 pupils from Grades VII, VIII, and IX in twelve different cities. About half of these were taught with the aid of films, the remainder serving as control groups. A course of study was prepared upon ten topics, which were studied from the first week in February until the middle of May. This course was put in the hands of all the teachers. Those teaching the experimental classes had some additional instructions relating to the showing of the films. The ten topics, on each of which there was a film, were *hot air heating, atmospheric pressure, compressed air, water cycle, water*

[33] Wood, Ben D., and Freeman, Frank N., *Motion Pictures in the Classroom*. Boston: Houghton Mifflin Company, 1929.

supply, purifying water, limestone and marble, sand and clay, reforestation, and *planting and care of trees.* The groups were equated on the basis of an intelligence test and an objective achievement test in general science. The results of the experiment were measured by a comprehensive test given both at the beginning and end of the experiment and by a modified form of the essay examination, which was scored objectively. These tests showed that, although the experimental group was below the average of the control group in both intelligence and achievement at the beginning of the experiment, they were considerably above the average of that group in both the comprehensive and modified essay tests. In statistical terms they were 20 percent of the S.D. below the average of the control group at the beginning of the experiment, and 78.2 percent of the S.D. above their average at the end of the experiment. This is a large change to occur in the average of such a large group, and shows that the motion-picture film can make a definite contribution to the learning of science. It is probable that these gains could have been made by other visual aids such as drawings, charts, and still pictures, but this is a matter to be settled by other experiments.

The comparative value of the usual reading-recitation form of presentation and various forms of visual presentation with the motion-picture film was the problem of an experiment in teaching a topic in agricultural science made by Albertson and Reed.[34] They used a total of 701 boys in 16 high schools and four different presentations, one nonvisual and three visual. These were: (a) nonvisual, reading 25 minutes, recitation 40 minutes; (b)

[34] Albertson, Fred, and Reed, Homer B., "The Relative Value of the Motion-Picture Films as a Teaching Device in the Field of Agriculture," *International Review of Educational Cimematography,* Vol. III (1931), pp. 859–865.

visual, reading 25 minutes, film 15 minutes, recitation 25 minutes; (c) visual, film 15 minutes, reading 10 minutes, recitation 40 minutes; (d) visual, film lecture 25 minutes, recitation 40 minutes. The material used for the study was a selection from a government bulletin on the control of the alfalfa weevil. The boys used in the experiment were divided into four equal groups by means of a composite score derived from an intelligence test, a reading test, and high-school grades. The results of the presentation were measured by means of informal objective tests given three times: immediately after the presentation, one week after, and one month after. To make the scores easily comparable the averages of the visual presentations were converted into percentages of the average of the nonvisual presentation. For the group as a whole, in the immediate test the visual methods were about 2 percent better than the nonvisual; in the test after one week they were about 4.2 percent better; and in the test after one month they were 5.5 percent better. When the whole group was divided into fourths, it was found that these differences were insignificantly small for the highest fourth of the group but significantly large for the lowest fourth. For the last group the visual presentations were an average of 5.7 percent better than the nonvisual. This advantage increased to 9.1 after one week, and to 10.9 after one month. These results show, then, that visual methods are better than the nonvisual, that this advantage increases with the lapse of time after the presentation, and that the most significant advantage is found in the lowest fourth of the group. Little difference was found between the various visual methods, but in most cases the *D* method, or film-lecture presentation, was found to be the best. When the results were analyzed with reference to the relation between the form

of presentation and the type of subject matter to which a question referred, it was found that the visual methods yielded about 21 percent more error than the nonvisual on abstract and theoretical subject matter, that on questions calling for generalizations there was little difference between the visual and the nonvisual methods, and that on questions referring to action the visual methods showed 27 percent less error than the nonvisual. This shows that motion-picture film was most effective for teaching action. When the results were analyzed to show the relation between the form of presentation and the variability of the achievement, it was found that the variability was much less for the visual methods than for the nonvisual. For the whole group it was 12 percent less in the immediate test, 20 percent less in the test after one week, and 25 percent less in the test after one month. For the lowest fourth in the immediate test it was 41 percent less in the visual than in the nonvisual presentation. This increased to 50 percent after one week. These results show that the motion-picture film presents facts to all members of the group with much more nearly equal effectiveness than does the usual reading-recitation procedure.

The experiments on the methods of presenting the subject matter of science are open to several criticisms. First, the methods investigated are not sufficiently standardized to make definite comparisons possible. Such methods as inductive, deductive, unit plan, daily recitations, textbook, laboratory, developmental, lecture, and lecture demonstration do not always have the same meanings for different investigators. Some investigators fail to give the detailed procedures specified and rely too much on general descriptive terms. Second, many experiments were too brief. Some investigators attempted to evaluate certain teaching procedures in three days.

Third, some failed to make sure that the groups were equivalent. Fourth, even when controlled groups were used, the reliabilities of the differences between them were not given. Fifth, too many variables were included in a given method. The largest uncontrolled variable was the teacher. This factor is so important that it may determine the outcome regardless of the method used, but it is often overlooked. These defects are incidental to the immaturity of the science of teaching science, but they can all be remedied. They do not necessarily invalidate the conclusions reached, but they call for further experiments. More decisive experiments are needed on deductive procedures; on the unit plan versus daily assignments; on the various forms of non-laboratory methods, such as lecture, textbook, and developmental; on non-laboratory versus laboratory procedures; and on the various aspects of laboratory work, such as the length of the laboratory period, the forms of the experimental write-up, the value of drawings, the comparative value of types of drawings, and the comparative value of different sensory modes of presentation.

Summary

The principle of organization may be applied to teaching science through methods of presentation which make it meaningful.

The inductive method has the advantage of deriving concepts from experience, but there is no clear proof that it is superior to the deductive when the latter is followed by numerous concrete applications.

According to experiments the unit plan is not inferior to the plan of daily recitations. It has strong advantages in providing opportunities for integrating the subject and making it more meaningful.

Of three methods of teaching general science—the developmental, the lecture, and the textbook—Hunter found the developmental superior for learning and retention. In this method the teacher developed a point by drawing out the experience of pupils by rapid-fire questions. Klopp, who made an extensive experiment on the same methods, concluded that the average child requires more than a textbook, and that he must be directed by the teacher through demonstration and discussion. He also stated that the maximum success in physics and in botany may be obtained by a combination of the textbook and lecture methods; and in zoölogy, by a combination of the textbook and demonstration methods.

The study-guide method has been found useful in developing both high achievement in science and independence in methods of investigation. It emphasizes the importance of training the student in asking the proper questions in a given science and in methods of finding the answer to them rather than simply learning facts about the science.

Mayman found that of three methods used in teaching science, a demonstration accompanied by some explanation was superior to lecturing alone, and that lecturing was superior to reading written lessons. Wiley, however, found that a textbook-recitation method was superior to an individual-laboratory method, and that the latter was superior to the lecture method. The differences between all these methods were small. Neither experiment was sufficient to warrant final conclusions.

More than sixteen experiments have been made on the comparative value of lecture-demonstration experiments by the teacher and individual-laboratory experiments by the student, with some results in favor of each. The outcome depends a great deal upon how the results are

measured. If they are measured by objective tests of information and of comprehension, no consistent significant differences are found in favor of either method. If the results are measured by a performance test of the student's ability to go into the laboratory and do an experiment, the individual-laboratory method is far better. The choice between these two methods, then, depends on the objectives of the study of science. If the objective is merely information, understanding, and appreciation, then the lecture demonstration is to be preferred because of its economy. But if the objective is not only information, but also ability to control and manipulate the materials studied in science, then individual laboratory work is the proper method.

Not all methods of doing laboratory work are equally effective. According to an individual-performance test given by Horton, the most effective method is doing individual laboratory work by the problem method without directions. The next best is doing individual laboratory work according to generalizations from general directions. The next best is doing individual laboratory work from printed directions in a manual, and the poorest is the lecture-demonstration method. In Walter's experiment also individual laboratory work without directions proved to be the best, but the lecture-demonstration method was superior to the individual method with printed directions. According to these results diminishing guidance seems to be the ideal procedure.

Writing out an experiment in full yields much better results than merely observing an experiment and taking notes on it. There is, however, little value in copying the details of a procedure from a manual. Illustrating the procedures by a series of diagrams, or the so-called diagram method, is better than this.

In physics the rotation method, in which the members of the class do the different experiments in turn, is superior to the even-front system, in which all members of the class do the same experiment at the same time.

If students have a choice between studying and drawing biological specimens, the former yields a better knowledge of the structure than the latter. But if drawings are made, it is better to make them diagrammatic and analytical rather than exact representations or reproductions.

Within limits the length of the laboratory period is not an important factor in determining the amount of information which can be obtained from it. According to experiments one-hour periods are just as effective as two-hour periods. Besides, they have the advantage of simplifying the schedule and of making possible a closer coördination between class work and laboratory work.

With respect to visual aids Huebner found that a teacher's drawings were superior to either models or charts in teaching plant structures.

Demonstration experiments by the living teacher yield better results than the same experiments shown by a motion-picture film.

In an extensive experiment made by Wood and Freeman it was found that children who were taught ten leading units in general science with the aid of motion-picture films made larger average gains than an equal group of children taught without them.

In an experiment by Albertson and Reed it was found that presentation of a lesson in agricultural science was, in general, more effective with the motion-picture film than with the usual reading-recitation procedure, but that the advantage was principally with the lowest fourth of the group. With respect to the relation between form

of presentation and subject matter, it was found that visual methods were superior to nonvisual for teaching action, that the two methods were about equally effective for teaching generalizations, and that the visual methods were inferior to the nonvisual for teaching theoretical and abstract topics. With respect to variability it was found that the visual methods presented the subject matter to all members of the class with more nearly equal effectiveness than did the nonvisual. That is, the visual methods yielded a lower variability than the nonvisual.

Supplementary Reading

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CHAPTER 24

Science: Individual Differences

In this chapter we shall discuss the relation of such factors as length of study, grade, intelligence, sex, other subjects, the teacher, the individual, and retention to achievement in science.

Relation of Achievement to Length of Study

Although there are many standardized tests in science, only a few give achievement scores in relation to the grade of the pupil as most science courses except chemistry are one-year courses. Even chemistry is a one-year course in most high schools. Some tests give norms for the end of the first semester, and in such cases, a comparison is possible for the first and second semesters. The Ruch-Popenoe General Science Test is an example. It contains 90 items, of which 30 percent relate to biological science, 12 percent to chemistry, 38 percent to physics, and 20 percent to earth science. The median score for the end of the first semester for this test is 28.1, and for the end of the second semester, 35.7. The Columbia Research Bureau Chemistry Test has norms for two and three semesters of the study of chemistry. It consists of three parts: one on informational items, one on equations, and one on problems. The maximum score is 340 points. The norm at the end of two semesters is 68 points, and at the end of three semesters, 90 points. Those who have completed two semesters' work but do not take the test until one semester after the completion of the course

make a median score of 54 points. After a lapse of two semesters the corresponding score is 38 points.

S. G. Rich's Chemistry Test is one of the few tests in science which has norms from 0.5 to 4 semesters of study. This test includes the following four phases of achievement in chemistry: ability to think, information, ability to solve numerical problems, and habits and knowledge acquired from work in the laboratory. Each form of the test has 25 questions. It shows that the average number of questions answered correctly increases from 10.3 at the end of the first half semester to 15.5 at the end of three and one-half semesters. These results show that achievement in science is no exception to the general rule that achievement increases with the length of study. If other science tests had norms for more than one year, they would undoubtedly show the same characteristic. It is unfortunate that most science tests show norms for only one-year courses. This is due to the fact that science is offered piecemeal in one-year courses. Unlike the study of language or English, it does not offer a progressive development from year to year. This is a result of the fact that the special sciences, as developed in the universities, were written down to high-school students in the same form. This manner of presentation fails to show the student the interrelations between the sciences or to give him an appreciation of their common values. Undoubtedly the future development of the teaching of science will develop general science into a three- or four-year course, and in doing so, will present to the student a progressive development of organized and interrelated information.

The relation of achievement in science to the length of study may be seen best in the changes which occur in the conceptions of the materials of science as a result of the study of science. A study of such changes was made

by Black.[1] He had students write essays or answer questions or write words associated with such topics as weight, mass, gravity, heat, light, dew, rainbow, and so forth. He used four groups of students: two from Grade IX, and two from Grade XI. In Grade IX one had studied general science and one had not. Similarly, in Grade XI one had studied physics and one had not. By comparing these groups with one other, it was possible to see the changes resulting from the study of each course and also from the difference in grade level. In general, these concepts change from vague and indefinite ones to ones which are definite and scientific. Very little change is due to a difference in grade level, but a considerable change is made by the study of the subject. What some of these changes are is illustrated by the notions expressed on light. The non-science group from Grade IX defined light as "what enables us to see," "rays of the sun," "sun's reflection," "a power from the sun," "the opposite of dark." The non-science group from Grade XI gave the same definitions except that 5 percent of them defined light as "a form of energy from the sun that makes plants grow." In Grade IX only 3 percent gave this definition. Strange as it may seem, the study of a course in general science made very little change in the conceptions of light. "Reflection of sun on earth," "what enables us to see," and "rays from a bright thing" were still the most frequent definitions, although about 7 percent of this group defined light as a form of energy. Important changes, however, were made by taking a course in physics. In Grades XI and XII about 38 percent of those who had studied physics defined light as a form of energy.

[1] Black, Oswald F., *The Development of Certain Concepts of Physics in High School Students.* Doctor's thesis, Columbia University, 1930. Published by "Die Weste," Potchestroom, South Africa, and distributed by Seiler's Book Store, New York City.

A small number, about 6 percent, defined light as "a wave motion," "a vibration of the molecules," "a vibration of the electrons," and so on, but just how much meaning these expressions had for the students is open to question.

Black found six stages which a concept may go through before it becomes scientific. In case of the rainbow they were as follows:

1. No idea as to how it is formed.
2. The phenomenon is merely described, for example, "a coloring in the sky" or "a colored ribbon."
3. Totally erroneous notions, for example, "reflection of lightning from rain drops."
4. Vague or naïve notions, for example "sun shines on the rain giving the colors."
5. Incompletely scientific, for example, "refraction of sunlight in raindrops."
6. Completely scientific, for example, "solar spectrum caused by the refraction of sunlight in rain drops" or "dispersion and total internal reflection in rain drops."

While in most cases a student may go through all of these stages, there is no reason why a student should not progress directly from an indefinite and vague notion to one that is definite and scientific. But there is a reason why not all students can progress to a scientific concept; that is, that it is too difficult for the mental level of the pupil. Black found that pupils from Grade IX could not form a scientific concept of mass, regardless of which method of teaching was used. Even in Grades XI and XII many did not understand this concept. It seems, however, that more than 15 percent of the pupils should form scientific concepts from the study of general science, and that more than 50 percent of them should reach scientific conceptions of physical concepts in Grades XI and XII. If the facts found by Black are typical, then

we should not expect too much from the study of a year's course in science.

Black concluded from his study that two things are absolutely necessary in teaching science: (1) analysis and classification of existing notions of pre-science pupils, and (2) an examination of pupils' concepts after the necessary subject matter has been treated, and immediate application of remedial teaching if necessary.

Correlations with Intelligence

A number of correlations have been calculated between intelligence (I.Q.) and achievement in various science subjects. These show that the correlations center around .48 and that they are approximately as high for one science as for another. The correlation between general science and intelligence quotient was found to be .66 by Beard,[2] and .42 by Cramer;[3] between botany and I.Q. it was found to be .40 by Cramer; between zoölogy and I.Q. it was found to be .46 by Cramer; between physics and I.Q. it was found to be .68 by Hurd,[4] .45 by Lohr,[5] and .19 by Cramer; and between chemistry and I.Q. it was found to be .65 by Cramer and .46 by Powers.[6] These show, at any rate, that intelligence is one important factor that determines achievement in science.

[2] Beard, Burrus E., *The Contribution of Silent Reading Abilities to Achievement in High School General Science.* Master's thesis, University of Iowa, 1928.

[3] Cramer, W. F., "A Study of Some Achievements of Pupils in the Special Sciences—General Science versus Non-General Science Groups—in the High Schools of Kansas City, Missouri," *Science Education,* Vol. XIV (1930), pp. 505–517.

[4] Hurd, A. W., "Observations on Factors Determining Success in Physics." *School Science and Mathematics,* Vol. XXV (1925), pp. 121–131, 259–270.

[5] Lohr, Vergil C., "A Comparison of Some Tests Given in High-School Physics." *School Science and Mathematics,* Vol. XXVII (1927), pp. 74–85.

[6] Powers, S. R., "Achievement in High-School Chemistry, an Investigation of Subject Matter," *School Science and Mathematics,* Vol. XXV (1925), pp. 53–61.

Relation to Drive and Other Factors

That there are other factors than intellectual ability which determine achievement in science is evident from the fact that in some cases the achievement score is far beyond the intelligence score, and in other cases, it is far below. Hurd[7] reported a study of 17 college students who had wide discrepancies between their scores in achievement tests and their scores in intelligence tests in physics. Of them 6 had achievement scores that were one or more standard deviation units below their intelligence scores, and 11 had achievement scores that were one or more standard deviations above their intelligence scores. He called the former "non-achievers," and the latter "achievers." The non-achievers had an average intelligence quotient of 118; they made a score of 63 in the information test in physics and 33 in a problems test in physics. The achievers had an average intelligence quotient of 112; they made a score of 82 in the information test and 56 in the problems test. The total scholarship of the achievers, measured in terms of points for grades in all subjects, was about 40 percent higher than that of the non-achievers. Hurd referred to this factor that accounted for the superior achievement of the less able as "interest," "drive," "motive," and as "drive enhanced by motive or incentive." In a later study Hurd[8] discovered that, besides drive, a number of other factors had a positive correlation with achievement in science. These were liking the subject, having few trains of recreation, belonging to four clubs rather than no clubs, having a high I. Q., receiving no help in class work, sleeping 9 or 10 hours rather than 7 or less, having a pulse rate between

[7] Hurd, A. W., "Interest as a Factor in Achievement in Science," *Science Education*, Vol. XV (1930), pp. 54–60.

[8] *Ibid.*, "What Factors Make for Good or Poor Achievement in Science," *Science Education*, Vol. XX (1936), pp. 4–7.

70 and 80 rather than a higher or lower rate, belonging to a family of six rather than 3 or less, having a high rating in regularity and industry, and being a boy rather than a girl. Evidently the factors that account for achievement are very complex.

Correlations with Other Subjects

Achievement in science is also related to achievement in other subjects. According to Beard achievement in general science has a correlation of .51 with reading. According to Hurd achievement in physics has a correlation of .73 with mathematics, .59 with English, .44 with general science and biology, .44 with history, and .34 with industrial arts. According to Mathewson[9] ability in chemistry has a correlation of .50 with general science, .49 with mathematics, and .46 with reading. According to Burns[10] the correlation between chemistry and the general average score in the New York Regents' examination is .55, and with the average grades made in academic high-school subjects for three years it is .44. The general significance of these figures is that the abilities to learn the various academic subjects are all positively correlated; that ability in one science is no more closely related to ability in another science than it is to ability in a literary subject; that there appears to be no special ability for learning science; and that improvement in one subject should be followed by improvement in another subject. According to the last conclusion we should expect improvement in reading to be followed by improvement in general science, and improvement in mathe-

[9] Mathewson, Franklin T., *A Development and Standardization of a Prognosis Test for High-School Chemistry,* Master's thesis, University of Rochester, 1930.

[10] Burns, Arthur D., *The Influence of Certain Factors on the Ability to Succeed in Chemistry.* Master's thesis, New York State Teachers College, Albany, 1929.

matics to be followed by improvement in physics. Whether these correlations can be explained by common specific factors, or a common ability to deal with symbols, or by a common general ability is a theoretical question which the data as presented do not answer.

Sex Differences

The sex of pupils is related to significant differences in their achievement in science. An important investigation bearing upon this point was made by Victor P. Smith,[11] who selected 748 statements from textbooks commonly used in general science. He converted these into test questions and gave them to large numbers of boys and girls in six different states. He then selected the papers of 300 boys and 300 girls to be used as a basis for calculations. The questions were grouped according to subject matter, after which the median score for the questions on each topic for each sex was computed.

There were significant differences in favor of the girls in questions relating to clothing and food; there were no significant differences in questions relating to human biology and health, life processes and development, earth, weather, and geology; and there were significant differences in favor of the boys in questions relating to properties of matter, plant and animal biology, astronomy, chemistry, and physics. The differences were very striking in questions relating to electricity and applied mechanics. A corresponding difference in physics was found by Camp[12] in the Iowa Physics Test. He found medians of 40 and 31 for boys and girls, respectively. An

[11] Smith, Victor P., "Sex Differences in the Study of General Science," *Science*, Vol. LXXV (1932), pp. 55–57.

[12] Camp, Harold S., *Iowa Physics Test*, Bloomington, Illinois: Public School Publishing Company.

investigation of Bray[13] confirmed the differences found in chemistry. He found averages of 67.23 and 56.53 for men and women, respectively, in the Iowa Chemistry Training Test I given to 320 students at the end of a year's college course in chemistry.

It is probable that a large fraction of these differences is due to training. Since women have more information about clothing and food and men have more information about mechanics, the easiest explanation lies on the side of environment. Although there are significant sex differences in some branches of science, they are not wide enough to justify segregation of the sexes in the teaching of science. They do, however, show that a teacher should not expect the same level of achievement in physics and chemistry from women as from men.

Individual Differences Within a Class

Achievement in physics varies with the individual pupil. In fact, the wide individual differences in achievement in physics, as in other subjects, are the most striking facts in the psychology of school subjects. Hurd[14] gives some interesting results on the distribution of pupils before and after instruction in a certain unit in physics. They are given in Table 33.

We see that the instruction changed the mean from 12.21 to 33.84, the range from 0–45 to 0–65, and the standard deviation from 8.35 to 11.95. Upon such results Hurd concluded that instruction increased the individual differences. This, however, is on the assumption that

[13] Bray, Willis J., "A Study of the Achievements of Students of General Chemistry in College," *School Science and Mathematics*, Vol. XXXII (1932), pp. 19–29. Also "Achievement in General Chemistry as It Is Related to Certain Learning Abilities," *Science Education*, Vol. XVI (1932), pp. 149–162.

[14] Hurd, A. W., "Achievements of Students in Physics," *Science Education*, Vol. XIV (1930), pp. 437–447.

TABLE 33

DISTRIBUTION OF SCORES IN PHYSICS IN PRELIMINARY AND FINAL TESTS

(From Hurd, 1929. Possible Score, 73)

Score	Frequency in Preliminary Test	Frequency in Final Test
0	53	1
5	51	1
10	42	8
15	36	15
20	24	27
25	11	42
30	4	35
35	1	24
40	1	26
45	0	24
50	0	8
55	0	8
60	0	4
Total	223	223
Mean	12.21 − 1.49	33.84 − .8
V or 100 S.D./Mean	68.38	35.31

the units of the scale are equal, and that a gain from 60 to 65 is the same as a gain from 0 to 5. This is questionable. The units in various ranges of the scale are probably quite unequal, and a gain from 60 to 65 is probably far greater than one from 0 to 5. If so, the S. D. derived from one range of the scale is not directly comparable with S. D. derived from another range. Such a comparison, however, can be made by calculating the coefficient of variability or *V*, which is 100 S. D. ÷ mean. This shows a decrease from 68.38 to 35.31, and may be taken as an illustration of the general effect of instruction on individual differences. Such a result is favored by the fact that the amount of information to be learned is

limited, that the amount of possible improvement is limited, that the superior are allowed to get by with average scores, and that the inferior are prodded until they reach scores above passing. Under the conditions it is important to provide equal opportunities to all pupils for the learning of science.

Adjustment of Instruction to Individual Differences

The variation of scores in Table 33 shows that there is the same need of individualized instruction in science as in other subjects. The types of adjustment are the same as for mathematics and are applied in a similar manner. The differentiated-assignment plan, the Winnetka plan of individual instruction, supervised study, and the project plan are used so nearly in the same way that no further description of them is required. The opportunities for individual projects in the form of experiments and original investigations are unequalled in any other subject. If equipment is not available for laboratory experiments, there is always an opportunity for interesting field work. If a student is interested in neither but likes reading, there is a very large number of topics which may be investigated in this manner. If an individual is in need of case-study methods, the diagnostic procedure would be the same as in mathematics except for those tests relating specifically to science, such as scientific vocabulary, uses of apparatus, and the setting up and dismantling of apparatus.

The value of attention to individual needs in teaching science has been shown in experimental studies made by Hurd[15] and by Tyler.[16] Hurd demonstrated its value in

[15] Hurd, A. W., "Does Remedial Instruction Pay?" *School and Society*, Vol. XXXIV (1931), pp. 467–468.

[16] Tyler, Ralph W., "Some Findings from the Field of College Biology," *Science Education*, Vol. XVIII (1934), pp. 133–142.

physics and Tyler in biology. Tyler's work, in particular, showed the value of personal interviews and of remedial laboratory work. Personal interviews give the teacher a better understanding of the students' problems and needs, and the student a better understanding of the teacher's humanity and sympathetic interest. At Ohio State University students in botany and in zoölogy who had had personal interviews with their teachers had better scores than equally competent students who had not had those interviews. The amount of superiority varied from .5 to .6 of the difference between a grade of *C* and a grade of *B*. The value of remedial laboratory work for students encountering science difficulties was studied in zoölogy. The results of this experiment were that students who took the remedial work made a gain of .8 of the difference between a *C* and a *B* over equally competent students who did not take this work. Possibly the most effective method of conducting remedial work is to begin by making an analysis of the errors in the performances of pupils, then design instruction for the specific purpose of removing the causes of these errors. Such a procedure was followed by Fox.[17] His analysis of errors in general science showed that most of them fell into the following groups:

1. Lack of knowledge of principles or major ideas of general science
2. Lack of information in scientific procedure
3. Inability to read graphs, tabulations, and figures
4. Inability to make applications in a scientific manner
5. Failure to analyze scientifically, draw conclusions, and see relationships
6. Failure to comprehend new words in science
7. Limited experience of pupils in the field of science

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[17] Fox, Truman D., "The Discovery of Better Teaching Techniques for General Science," *Science Education*, Vol. XIX (1935), pp. 9–12.

In his remedial program Fox did not attempt to correct all sources of error, but only three: those relating to inaccurate observation, failure to get general ideas, and failure to understand new words. To improve the understanding of demonstration technique, pupils were quizzed on the purposes of different steps, told to observe such things as they were able, and were given drill in picking out the essentials. To improve ability to get general ideas the pupils were trained to read for the general idea, select the central idea, list subordinate ideas, and make outlines. To improve the understanding of new words pupils were asked to make their own lists of new terms, correlate them with their own experiences, and use the dictionary. Four equivalent classes were used to test the value of this remedial program, two control and two experimental. The latter, in five units of study, made 33.2 percent and 30.5 percent more gain respectively, than the former. The results show the value of using teaching procedures modified to meet individual needs.

Summary

Science courses in the secondary school are usually limited to one year; for this reason few tests show advancement in science through several grades. A few give semester norms, and these show progress in relation to the number of semesters of study.

Intelligence is one important factor which determines achievement in science. It appears to be no more important in one science than in another.

Traits of character which make up industry and zeal are important. The achievement of bright students lacking industry is usually below that of dull students who have it.

Achievement in science is positively correlated with

achievement in other academic subjects. Achievement in one science appears to be no more closely correlated with achievement in another science than with achievement in a literary subject. There appears to be no special ability making for success in science. Improvement in reading, however, is usually followed by improvement in general science, and improvement in mathematics should be followed by improvement in physics.

The sex of the pupils is related to significant differences in their achievements in science. Girls are superior in sciences relating to food and clothing. Boys are superior in astronomy, physics, and chemistry. There appear to be no significant differences in human biology and health.

The largest variation of achievement in science is shown in relation to the individual pupil. Some learn next to nothing while others learn about everything that is presented. The effect of training, however, is to reduce the relative differences between individuals and to make them more nearly equal in achievement.

Supplementary Reading

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Johnson, P. O., "The Measurement of Outcomes of Instruction other than Information," *School Science and Mathematics*, Vol. XXXIV (1934), pp. 26–33.

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to Adapt Instruction to Ability," *School Science and Mathematics*, Vol. XXVI (1936), pp. 510–514.

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CHAPTER 25

Science: Motivation and Materials

We have seen that pupils who have a strong zeal for achievement in science accomplish much more in relation to their capacity than those who lack this zeal. Some methods of cultivating this zeal are selecting materials which satisfy the interests and meet the needs of pupils, choosing materials which are readily learnable and offering them in quantities within the limits of a reasonable mastery, and selecting a set of criteria by which the proper materials may be chosen. In this chapter we shall review and discuss studies relating to these questions.

Studies of the Interests of Pupils

Approaches to the determination of the science needs of pupils have been made by studies of the interests of pupils in science, by analyses of the science reading materials offered in newspapers and popular journals, and by analyses of the needs in health information of the population. Numerous studies have been made of the interests of children and of adults in science. As samples of these studies we may take those made by Pollock,[1] Palmer [2] and Nettles.[3] For his study Pollock wrote a letter to pupils from Grade VIII, telling them of the numerous things studied in science and requesting them to write out the

[1] Pollock, C. A., *Children's Interests as a Basis of What to Teach in General Science.* Ohio State University Educational Research Bulletin, Vol. III (1924), pp. 3–6.

[2] Palmer, E. Lawrence, and others, *The Scientific Interests of Children Enrolled in Country Schools.* Cornell Rural School Leaflet, Vol. XVIII, September 1925.

[3] Nettles, C. H., "Science Topics That Are of Interest and Use to Adults," *Science Education,* Vol. XV (1931), pp. 139–146.

five questions which had the greatest interest for them. A total of 3,500 questions were received from children in 13 schools. These were classified according to subject matter and counted. The most important topics in their order of frequency from greatest to least were as follows:

1. Electricity
2. Stars
3. Radio
4. Heat
5. Lightning
6. Planets
7. Moon
8. Sun
9. Mars
10. Plants
11. Wind
12. Gravity
13. Air
14. Aeroplane
15. Earth
16. Light
17. Sound
18. Gas
19. Rotation
20. Clouds
21. Bacteria
22. Volcanoes
23. Animals
24. Trees
25. Machinery
26. Water supply
27. Sea
28. Earthquake
29. Snow
30. Anatomy
31. Nature
32. Radium
33. Food
34. Stones
35. Telephone
36. Engine
37. Rain
38. Fishing
39. Flowers
40. Photograph
41. Season
42. Cool

Palmer's study was an analysis of the science questions of rural school pupils sent by their teachers to *Cornell Rural School Leaflet* during the five-year period from 1921 to 1926. Many thousands of questions were sent in by 7,056 teachers. They were classified by years according to subject matter and according to the nature of the information desired. The variations in the types of questions from year to year were small. In 1925 66.8 percent of the questions related to zoölogy; 21.1 percent related to botany; 5.8 percent related to inorganic nature; 4.0 percent related to agriculture; and the remainder to miscellaneous matters. Within zoölogy the most im-

portant topics were invertebrates, birds, mammals, and reptiles. When the questions were classified according to the nature of the information desired, the rank order of the more important topics was habits, taxonomy (distribution), morphology (structure), physiology, and economy.

The study of Nettles dealt with the science interests of adults who were parents of school children. He had parents make two checks of a long list of topics in science: a check of the topics which interested the parents most, and a check of the topics they thought most useful. Although the correlation between interest and usefulness was fairly high, there were a number of cases where the two diverged. For example, such topics as aviation, astronomy, animal life, human body, radio, and disease ranked higher in interest than in usefulness; while such topics as water supply, lighting systems, heating systems, and insects ranked higher in usefulness than in interest.

Nettles also found that the rank of a topic in interest and in usefulness varied with the sex of the parent and with his amount of education. For men electricity and aviation ranked higher in interest than human body and food, but for women the reverse was true. Men with a high-school education ranked chemistry, hygiene, mechanics, oil, and ships much higher in usefulness than did the men without a high-school education, while the latter ranked aviation, food, lighting systems and water much higher than did men with a high-school education. Women with a high-school education ranked mechanics and radio much higher in usefulness than did women without a high-school education, while the latter ranked chemistry, food, electricity, heat, human body, hygiene, plants and water higher in usefulness than did those with a high-school education. According to this investigation

education seemed to improve the judgment of men, but spoil the judgment of women. Possibly this is because the women who replied to this questionnaire were mostly those who made a very limited study of science while in high school. The divergence between the ranks in interest and in usefulness, as well as the divergence between the rankings of the educated and uneducated, shows that studies of interests do not furnish an entirely reliable criterion for the selection of the materials in science. If there must be a choice between the interesting and the useful, education should emphasize the useful, although it may very well use the interesting as a stepping-stone to the useful.

If the results of these three studies are compared with respect to the field of science that is most interesting, we find little agreement. According to Pollock's study nearly all the topics relate to physics, astronomy, and physiography. According to Palmer's study over 80 percent of the questions relate to zoölogy and botany, while according to Nettles only about one third of the topics relate to biology. The studies made by Curtis and by Craig,[4] which were similar to that of Pollock, agree with Pollock's study in finding the majority of topics in the field of the physical sciences. Because of the character of these results no definite statements can be made concerning the interest order of various branches of science. The most probable explanation of these wide differences in interest order is that they are due to differences in age and to environmental influences. In the city of Los Angeles, where aviation is an important industry and where frequently large squadrons of planes

[4] Craig, Gerald S., "Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School," *Contributions to Education*, No. 276. New York: Teachers College, Columbia University, 1927.

may be seen flying, we may expect the interest in aviation to rank very high, while in rural New York, where the children are close to a rich animal and plant life, we may expect a strong interest in zoölogy and botany. If this explanation is correct, it suggests that interest studies of topics in science have principally a local value, and show how in each locality a psychological approach to the study of science may be made.

Studies of Scientific Content in Popular Journals

Studies of the scientific information needed for an intelligent reading of popular journals were made by Finley and Caldwell,[5] Curtis,[6] Hopkins,[7] Sites,[8] Searle and Ruch,[9] and some others. Those of Finley and Caldwell, Hopkins, and Searle and Ruch may be taken as typical of the group. Finley and Caldwell made a study of biological material in eleven daily newspapers. A total of 3,061 biological articles were found. Of these 897 related to health, 755 to animals, 660 to plants, 533 to food, 81 to organization of producers, 74 to nature, and 47 to evolution, while 14 were fictitious articles. The center of interest in all these articles, according to the investigators, is the relation of biology to the welfare of man. They stated that the conclusion should not be drawn that, because these biological articles have been found, they should be taught in the schools, but that the course

[5] Finley, Charles W., and Caldwell, Otis W., *Biology in the Public Press.* New York: Lincoln School of Teachers College, 1923.

[6] Curtis, Francis D., *A Synthesis and Evaluation of Subject Matter Topics in General Science.* Boston: Ginn and Company, 1929.

[7] Hopkins, L. Thomas, "A Study of Magazine and Newspaper Science Articles with Relation to Courses in Science," *School Science and Mathematics,* Vol. XXV (1925), pp. 793–800.

[8] Sites, John T., *Chemical Principles, Concepts, and Technical Terms Used in Science Magazines.* Master's thesis, University of Chicago, 1930.

[9] Searle, Albert H., and Ruch, Giles M., "A Study of Science Articles in Magazines," *School Science and Mathematics,* Vol. XXVI (1926), pp. 389–396.

in biology should consider them as part of the legitimate foundation upon which to proceed in constructing a course of study.

Hopkins's study included an analysis of the issues of four Denver daily papers for a month in 1924, and also of the issues for six months of *Popular Mechanics, Scientific American, Ladies' Home Journal, Good Housekeeping, The Saturday Evening Post, The Literary Digest, Country Gentleman,* and *Farm Journal.* He found that all sciences were distributed rather evenly throughout the newspapers, but that in each issue the biological material occupied about four times as much space as the physical, and ten times as much as the chemical material. He concluded from this that biology is the most important of all secondary-school sciences from the standpoint of general educational values, and that in a four-year high school the sequence of sciences should be (1) general science, (2) biology, (3) physics, and (4) chemistry. This is on the assumption that the frequency of the appearance of a topic in a journal is a reliable index of its educational value.

Searle and Ruch made an analysis of all the issues during a ten-year period ending December 31, 1923, of *The Literary Digest, The American Magazine, Review of Reviews, Current Opinion, National Geographic, Scribner's Magazine, World's Work,* and of the issues during five years and six months of *The Saturday Evening Post.* When classified according to subject matter it was found that 62.2 percent related to biology, 26.3 percent to physics, 5.1 percent to chemistry, 4.0 percent to general articles on science, and 2.4 percent to agriculture. Searle and Ruch also analyzed the frequency of the topics within each field of science. The three most frequent topics in biology were man, mammals, and health; in chemistry

they were processes, discoveries, and gases; in physics they were dynamics and machines, light, and matter; in general articles they were physiography, physiology, and textiles; and in agriculture they were animals, crops, and stationary machinery.

Both the studies by Hopkins and by Searle and Ruch agreed that biology is by far the scientific topic of most frequent occurrence in popular journals. This indicates that biological material, particularly if it relates to health, not only has journalistic value, but also meets a need felt by the reader. That the schools should teach the pupil enough science to enable him to read these materials intelligently is a reasonable obligation, but it is also clear that it is not the only criterion by which the selection of content should be determined. Besides safeguarding his health, the pupil needs also to make adjustments to modern industry, transportation, and communication. More than likely his vocation will lie somewhere in these fields, in which case he may need a good deal of science to fit himself for it. Then, too, the interests of individuals must always be considered, even if they are in disagreement with the frequency of topics found in journals.

Analysis of Difficulties That May Be Solved by Science

The needs of pupils in science may also be discovered by an analysis of difficulties and obstacles which may be solved or overcome by application of scientific information. Such a procedure was used by Laton [10] in selecting the materials for a health unit in a course in biology. First she looked up in the government reports the mor-

[10] Laton, Anita D., "The Psychology of Learning Applied to Health Education through Biology." *Contributions to Education*, No. 344. New York: Teachers College, Columbia University, 1929.

tality rates of diseases, then selected those infectious diseases which had high mortality rates and would interest pupils from Grade IX in her community. Those selected were chicken pox, colds, diphtheria, influenza, malaria, mumps, pneumonia, rabies, scarlet fever, whooping cough, and yellow fever. Her next step was to decide what should be taught about them. She decided on prevention of spread, as the most important information needed by a layman. Then she selected the facts which should be taught about each disease, with an eye to helping the layman prevent spread and making him interested in doing so. Having done this, she sought biological principles upon which these facts might be organized, comprehended, and tied up with the rest of the course in biology.

This objective and scientific procedure should be used more extensively than it has been. Just as there are difficulties in the use of English which may be remedied by the study of language and grammar, and difficulties in computation which may be remedied by the study of arithmetic, so there are difficulties in health, in the use of machinery, in the use of tools, in the care of a house, in the care of heating and lighting systems, in the care of clothing, in the growing of crops, in the storage and preservation of foods, in the preparation of foods, and so on, which may be removed by the study of science. Accurate information about such difficulties would give us a far more reliable basis for the selection of the materials of science than would studies of the scientific interests of children and of the frequency of the appearance of scientific topics in journals, but extensive researches of this type are not yet available.

If we attempt to summarize the scientific needs of the population by the results of studies which bear upon

them, it is evident that the results are not consistent. In the study of the scientific interests of children and adults made by Pollock, Curtis, Craig, and Nettles, only from 10 to 20 percent of the topics referred to the biological sciences. In Palmer's studies, however, about 88 percent of children's questions referred to biological topics. In the study of the frequency of scientific topics in popular journals made by Hopkins, over 75 percent of the topics referred to biology, while in the study of Searle and Ruch 62.2 percent of them were biological. Four of these studies show the need for a course which is principally nonbiological, while three show the need for a course which is principally biological. Courses in general science and biology would satisfy most of the needs of either group. We may say, then, that there is evidence of the need for these two courses.

How Well Do the Courses Offered Satisfy the Scientific Needs of the Population?

This question cannot be answered accurately except by a comparison of specific needs and specific offerings, but hardly sufficient studies have been made to make this possible. However, we can compare general needs and general offerings. An idea of the general offerings may be obtained from the survey of the teaching of science in secondary schools made by Curtis [11] in 1930. He sent a long and detailed questionnaire to the secondary schools of the North Central Association and obtained replies from 1,802 schools.

He found that the five most frequent offerings were physics, chemistry, general science, general biology, and agriculture. So far as the studies of scientific needs are

[11] Curtis, Francis D., "The Teaching of Science in Secondary Schools," *North Central Association Quarterly*, Vol. VI (1931), pp. 443–474.

reliable they indicate that general science and biology should come far ahead of physics and chemistry. The position of the last two is due to the force of tradition and the comparatively long time during which these sciences have been taught. Although the frequency of general science and of biology is less than it should be, we must consider that they are of recent innovation and that offerings in them have grown rapidly. In an investigation made by Hunter in 1908 he found only eight courses in general science out of a total of 276 schools reporting. At that time general science as a course was practically non-existent. Since then the offerings have grown from the lowest rank in frequency to third highest. The probability is that in a few years general science will be the most frequent course in science in the secondary schools and that biology will be the second most frequent. This would be in agreement with existing measures of needs.

Specific Needs and Specific Offerings

As stated above the adequacy of courses in science for meeting the needs of students can be determined only by a comparison of specific needs and specific contents. A specific need may be determined by interest, importance to human welfare, or relation to a scientific principle; specific content may be judged by its quality. We may take frequency of mention in journals as a rough measure of the relation of a topic to human interest and welfare, and we may take amount of space or number of words devoted to a topic as a rough measure of the relative importance of the content. An idea of how well these two compare may be obtained by an examination of the rank of topics in order of frequency as found in the study of Searle and Ruch, and the rank of topics in order of amount of space devoted to each as found in the study of

Richards,[12] who counted the number of words devoted to each topic in six widely used textbooks.

There is some correspondence in the two rankings, for all terms in the first ranking appear in some form in the second. There are some terms in the second ranking, however, which do not appear in the first. These include algae, classification, nervous system and sense organs, roots and their work, crayfish, metazoa and protozoa, and worms. These topics do not have much journalistic value, but they do have great scientific value. For example: algae are valuable for teaching the process of reproduction; classification is important for making the numerous forms of life comprehensible; protozoa are important for teaching the essential characteristics of living substance; worms are important for teaching various adaptations of life to environment; and the nervous system is important for making comprehensible how an organism, which consists of millions of cells, may act as a unified organism. This brings to light another criticism of the journalistic method of determining the curriculum, namely, that it takes little account of the importance of a topic for teaching a scientific principle.

Although there is some correspondence between specific need and specific content, as shown in the foregoing comparison, the divergence between them is probably more striking. The principal value of such a comparison is to show how far apart existing measures between need and content are, and the need of finding some method of bringing the two classes together. If we had truer measures of each factor, the divergence would probably be just as great as it is between these imperfect ones, but the chances of bringing them together would be better.

[12] Richards, Oscar W., "The Present Content of Biology in Secondary Schools," *School Science and Mathematics*, Vol. XXIII (1923), pp. 409–414.

Is the Quantity and Quality of Facts in Secondary-School Science Such as to Be Readily Learned?

This question cannot be definitely answered, but approaches to an answer may be found in the number of ideas contained in textbooks on science, the number of new words or technical terms in them, and the achievements shown by pupils at the end of a period of study. The writer has attempted to measure the number of ideas contained in textbooks on science by counting the number of paragraphs in two books on general science, four on biology, three on physics, and four on chemistry. The average was close to 1,400 in general science, 1,700 in biology, 1,400 in physics, and 1,600 in chemistry. This is very large, indeed. We are reasonably safe in saying that a high-school student cannot hope to master that many separate facts in a course during a year, although it may be possible to do so if all the facts are related to a comparatively small number of fundamental principles.

An index to the quality or difficulty of the material is the number of new words in the text. Studies of new words in textbooks in science were made by Pressey,[13] and by Powers.[14] Pressey had several persons read a book and mark the words which they thought to be technical. Lists of these words were then submitted to teachers of science who were asked to mark them for importance. From these she made lists of words for each subject, and classified them as "essential," "accessory," and "not necessary." The results are given in Table 34.

The correspondence between the total number of technical words in a subject and number of paragraphs in a

[13] Pressey, Luella Cole, "The Determination of the Technical Vocabulary of the School Subjects," *School and Society*, Vol. XX (1924), pp. 91–96.

[14] Powers, S. R., "The Vocabularies of High-School Science Textbooks," *Teachers College Record*, Vol. XXVI (1925), pp. 368–392.

TABLE 34

NUMBERS OF WORDS ESSENTIAL, ACCESSORY, AND NOT NECESSARY FOR VARIOUS BRANCHES OF SCIENCE

(From L. C. Pressey, 1924)

Subject	Essential	Accessory	Not Necessary	Total
Common science	191	24		215
General science	916	648		1,564
Biology	675	677	41	1,393
Chemistry	765	488	44	1,297
Physics	709	331		1,040
Geography	313	690	129	1,132
Physiology	293	493	80	866

textbook is rather close, particularly in general science and in biology. The number of new words to be learned in a science course is greater even than the number of new words for a year's course in a foreign language, in which most of the attention is given to the study of words. In addition, the student is expected to master a large content. Together, these requirements make the course in science a heavy load. A remedy for this situation may be effected by reducing the content to those concepts that are agreed upon as really important. Kitzmiller[15] attempted to sift out the most important chemical elements by restricting the list to those which were mentioned on nine or more pages in three text books. This reduced the list of important ones from 81 to 50. It is possible that similar reductions could be made in other subjects.

If we use achievement tests to measure the amount of knowledge acquired or retained from a year's study of a science, we must conclude that for most students it is far below the amount presented. Kitzmiller made two tests on the elements most frequently mentioned in high-

[15] Kitzmiller, Albans Blaine, *A Study of Certain Vocabulary Problems in High-School Science*. Doctor's thesis, Ohio State University, 1928.

school texts. In one of these he gave the student the symbols of the 40 most frequently mentioned chemical elements and required him to name the elements. In the other he gave the student the most important uses or occurrences of an element and required him to name the element which has these uses or occurrences. Kitzmiller also made a similar test of the forty most frequently mentioned pieces of apparatus. He gave the student the uses and required him to name the apparatus. These tests were given to high-school and college students who had studied various amounts of chemistry at varying intervals.

Those who had completed three fourths of a year of chemistry in high school could identify the symbols of 29 elements. Those who had had a year of chemistry in high school, but had not taken any more in college remembered only 17 of the symbols, but those who had completed just a year of college chemistry could identify 39, or all but one of the symbols. Those who had completed a year of college chemistry, but who were not studying at the time of the test remembered 30 of the symbols. In the list of the uses of the elements high school students could name only 17 out of the 40, while those at the end of a year of college chemistry could name 28.

Educationally it is more important to state the uses of an element than it is to identify its symbol. Therefore, a year's course seems to be insufficient for mastery of more that half of the fundamental concepts. And from one fourth to one half of these are forgotten after a year or more of no study of the subject. Hurd,[16] who gave an objective test on the important content of a unit of physics in high school, stated that none of 243 pupils

[16] Hurd, A. W., "Present Inadequacies and Suggested Remedies in the Teaching of Physics," *School Science and Mathematics*, Vol. XXV (1930), pp. 539–546.

made a perfect score, that only 3 items out of 45 received as many as 90 percent correct responses; that 23 items received a score of 50 percent correct; that 22 items received a score of less than 50 percent correct; and that 4 items received a score of less than 10 percent. He concluded that this indicates either that pupils do not put forth a reasonable effort, that the work is too difficult, or that correct methods of instruction are not used. From these facts we can at least say that the amount learned and retained is small in proportion to the amount presented, and that something should be done to reduce the discrepancy. The remedy lies in better methods of learning and in better organization with reference to fundamentals, rather than in a large reduction in the amount of material presented.

By What Criteria Shall the Content for Science Courses Be Selected?

The following criteria have been used for selecting content in science: frequency of mention in journals; frequency of mention in the questions of children and adults, and in expressions of their scientific interests; frequency of mention in curricular investigations; consensus of opinion among teachers and experts; life activities; common content in different textbooks; and the relevancy of materials for illustrating scientific principles. The ultimate criterion presumably is human value, and all of these lesser criteria are simply devices for finding that scientific content which has the greatest human value. We have already pointed out that many things, such as algae and nervous system, have great scientific value but little journalistic value. The objection to children's questions and to expressions of their interests is that they are largely due to the accidents of environment, although they do

afford a key for a psychological approach to the teaching of a science. Frequency of mention in curricular investigations should be a valuable criterion, but whatever value it has will depend on the value of each criterion used in the original investigations. Consensus of opinion among teachers and experts is probably the nearest we can get to the ultimate criterion, for who is in a better position than a teacher and an expert in the subject matter to judge all those values which should enter into the selection of content? Of course teachers are often inattentive to practical values, and overestimate the value of their own subject matter in relation to that which is less familiar to them, but a check on this weakness may be found in a proper weighting of other criteria.

That the teaching of science should relate to the life activities involving them everybody would agree, but that their frequency is a proper criterion for the selection of content is another question. In selecting content for a high-school course in agricultural engineering, attention should be given to the farmer's activities in the use of tools and machinery. In such a study the hammer would probably prove to be the most frequently used tool. But this does not mean that most of the subject matter should relate to the hammer, for the hammer does not involve a great deal of science nor does it get out of order frequently or cause many difficulties when it is out of repair. A more practical criterion than frequency of activities in using machinery and tools would be frequency of difficulties in their use. The content common to a number of textbooks is recognized as a valuable method of selecting the best materials, but it is open to the objection that writers of textbooks have a large respect for tradition and are careful to make their content regular. That materials which are best adapted for illustrating important scientific

principles should be selected for discussion is both good science and good pedagogy. For example, if algae are well adapted for illustrating the elements of the reproductive process, they should be used for that purpose, even if magazine articles give them few mentions. But the illustration of the process with simple materials should not prevent, but lead us to, the explanation of the process in complex forms. Thus, every criterion has some merits and some deficiencies. If a mistake is made in the use of criteria, it is in restricting the selection of content to one or two criteria, to the exclusion of others. The wise judge will always try to obtain a balanced judgment of all values.

Summary

Efforts have been made to determine the curricular needs of students in science by studies of the scientific interests of children and of adults, by studies of the frequency of mention of scientific topics in popular journals, and by studies of obstacles which may be overcome by the application of scientific information. Studies of scientific interests of children have the value of supplying the basis for a psychological approach to the study of science, but they are too much influenced by the accidents of environment to be allowed to determine the full content of science. Frequency of mention in journals is one index of interests and needs, but it ignores many important scientific topics which have little journalistic value. Studies of obstacles which may be overcome by scientific information are the best, but so far not enough of them have been made to select a curriculum.

The question of the satisfactoriness of the curriculum in science for meeting present needs cannot be accurately answered. The greatest demand, according to studies of

scientific interests, is for courses in general science and biology, while the most frequent offerings are in physics and chemistry. Studies of specific needs and specific offerings show only a small amount of correspondence. The greatest difficulty here is the lack of accurate measures either of needs or of content.

There is a wide discrepancy between the number of ideas mastered in science and the number of ideas presented. If we measure the number of ideas in a science course by the number of paragraphs in the text, there are about 1,500 of them. If we measure the number of ideas by the number of technical terms, the average is nearly 1,200. Tests of the degree to which these terms are mastered show that a large proportion may be correctly identified while the course is being studied, but that over half of them are forgotten in less than a year. There is also a wide variation in the amount mastered. One investigation indicates that either the course is too difficult or the students do not put forth enough effort or that improper methods of teaching are being used.

The materials for a course in science should be selected not wholly by one criterion but by a balanced judgment of many of them.

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